(No Model.) 8 Sheets—Sheet 1.

E. R. BRANSON.

CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

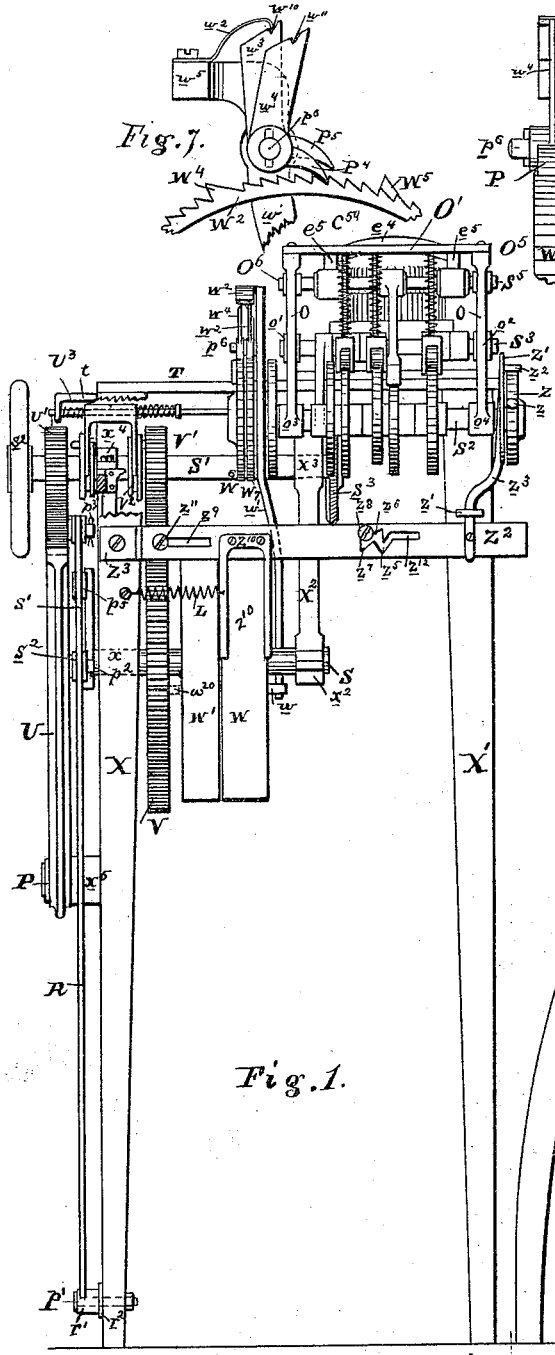

Fig. 1.

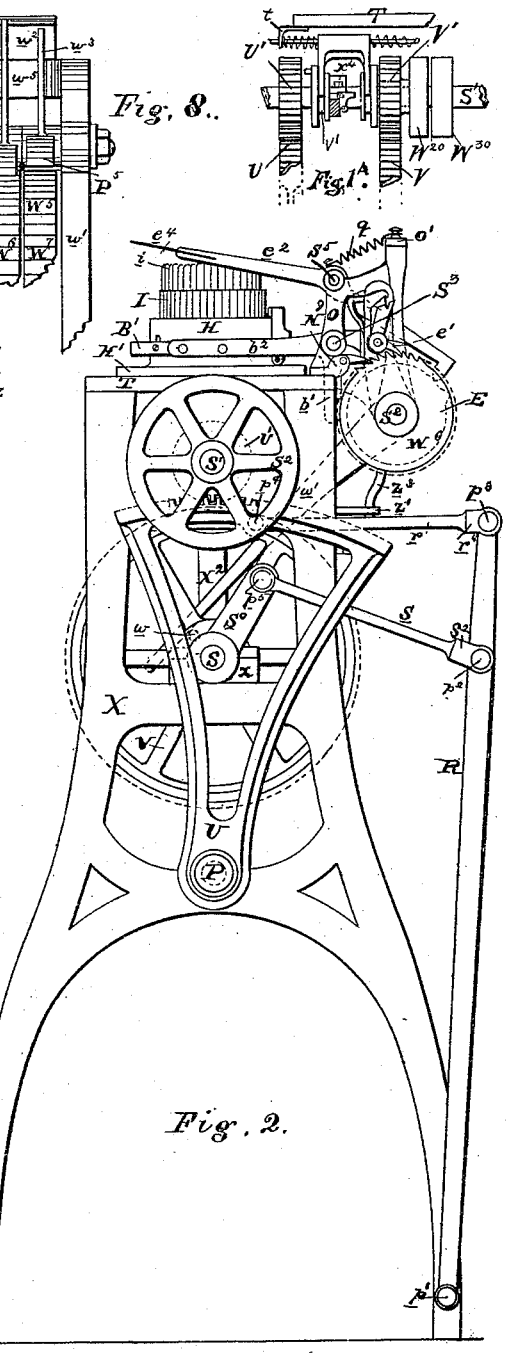

Fig. 2.

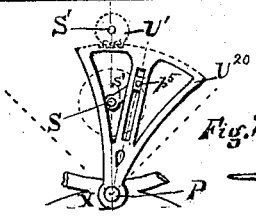

Fig. 2A.

Fig. 8.

Fig. 1A.

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E. R. BRANSON.

CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

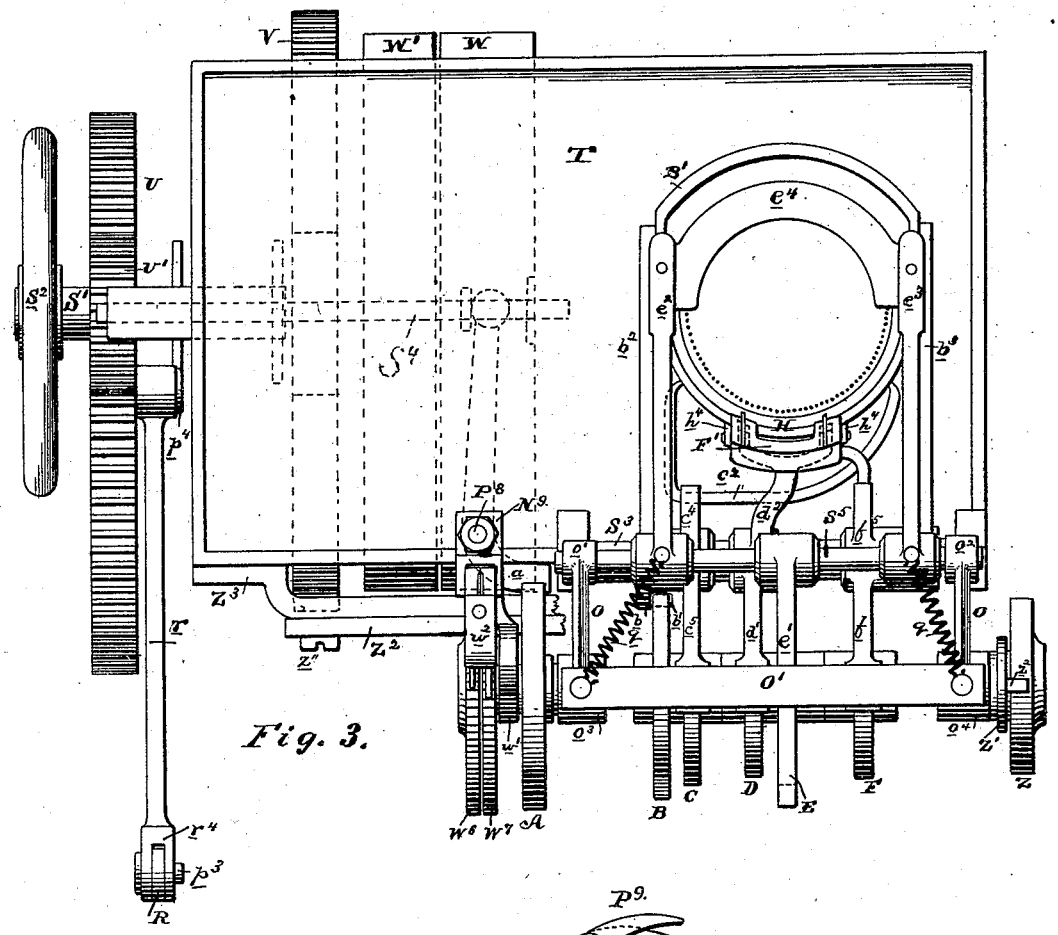

Fig. 3.

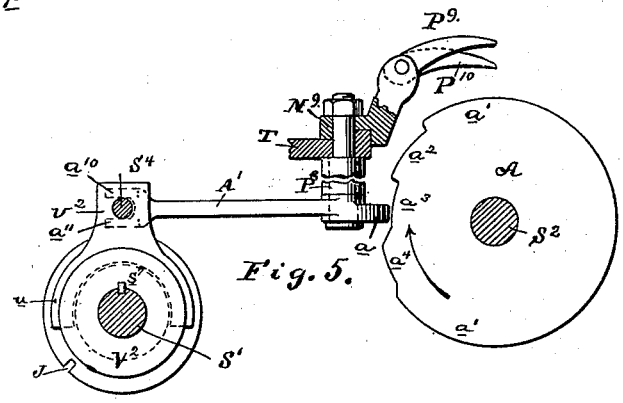

Fig. 5.

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(No Model.) 8 Sheets—Sheet 3.

E. R. BRANSON.

CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

Fig. 4.

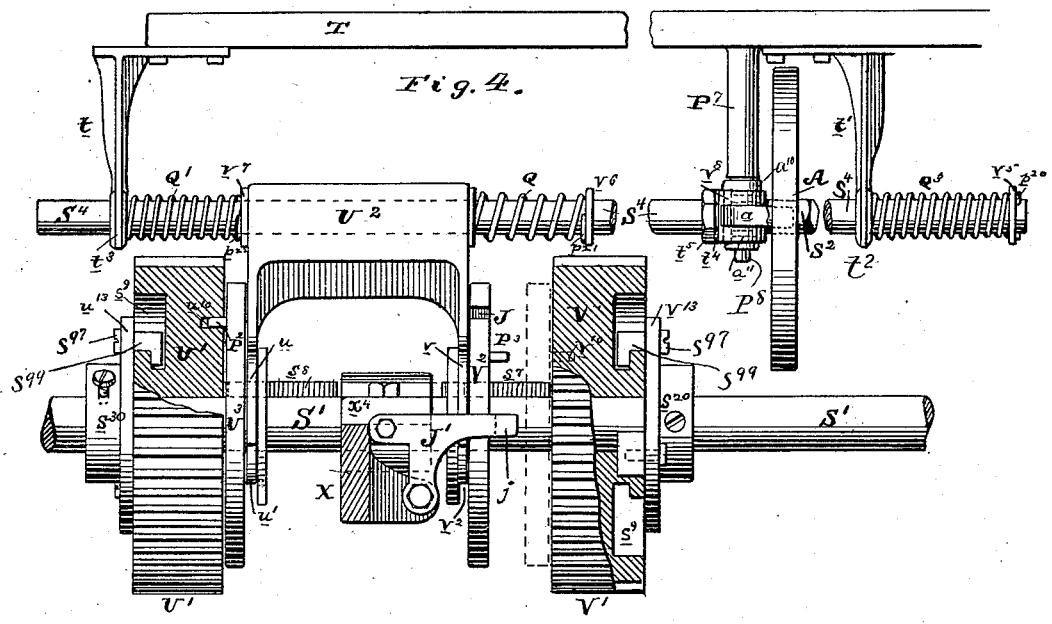


Fig. 4A

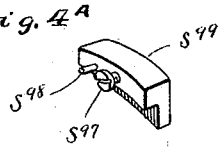


Fig. 5A

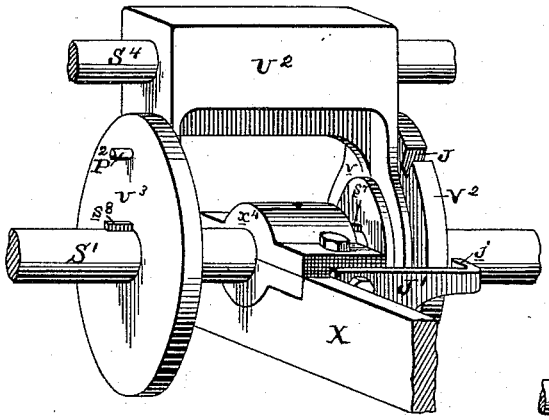
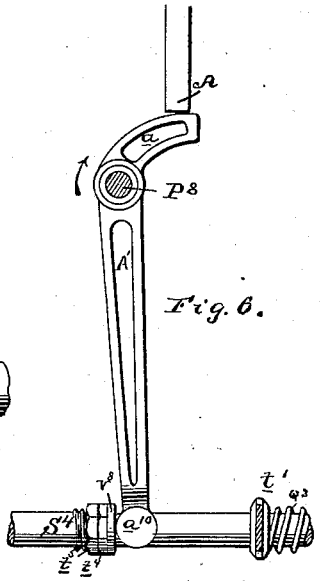


Fig. 6.



Attest:
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(No Model.) 8 Sheets—Sheet 4.

E. R. BRANSON.

CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

FIG. 7 A.

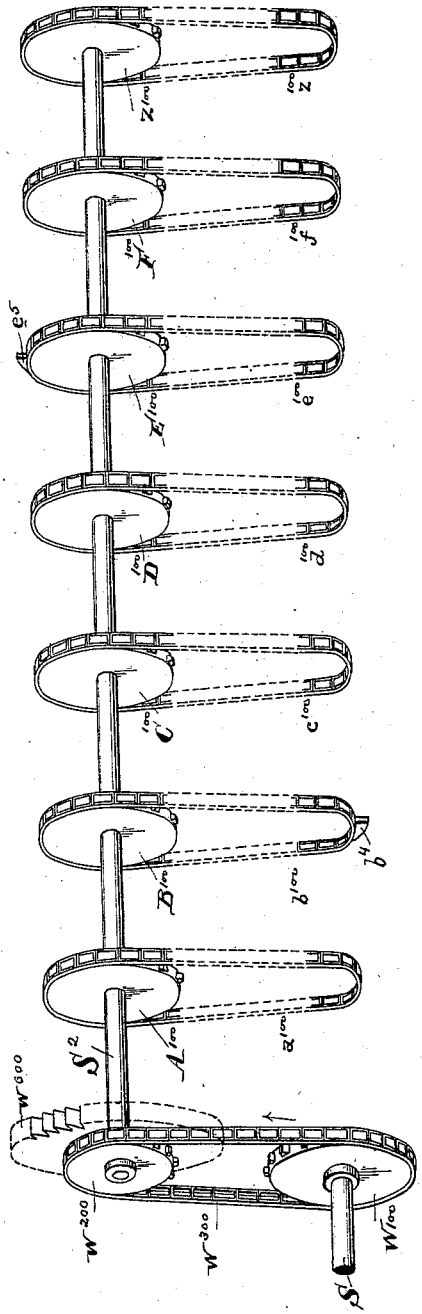
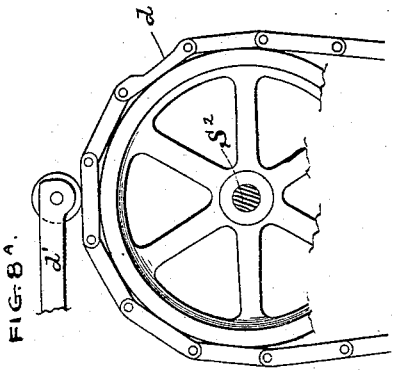


FIG. 8 A.



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H. W. Van Pool.

INVENTOR:

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Francis T. Chambers

(No Model.) 8 Sheets—Sheet 5.

E. R. BRANSON.

CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

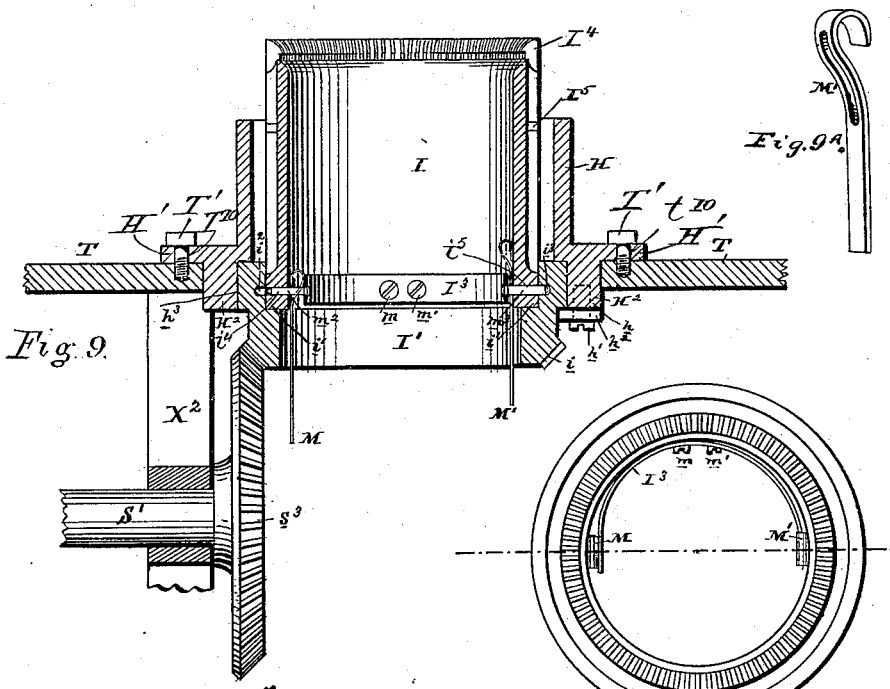

Fig. 9.

Fig. 9A.

Fig. 10.

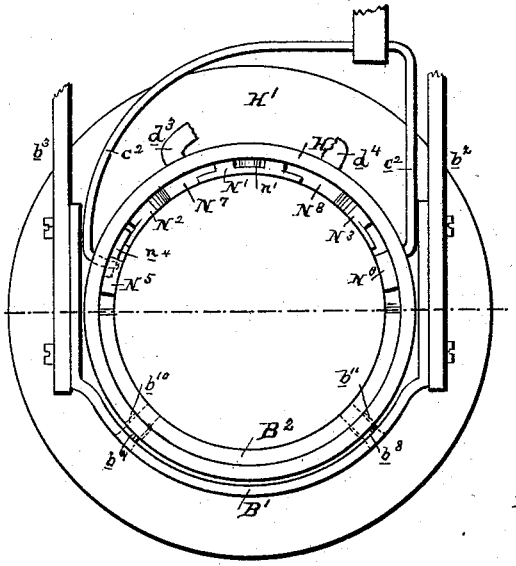

Fig. 11.

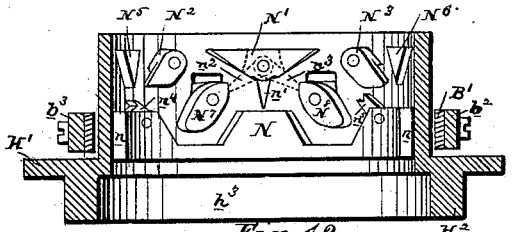

Fig. 12.

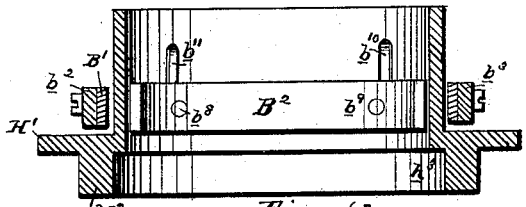

Fig. 13.

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CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

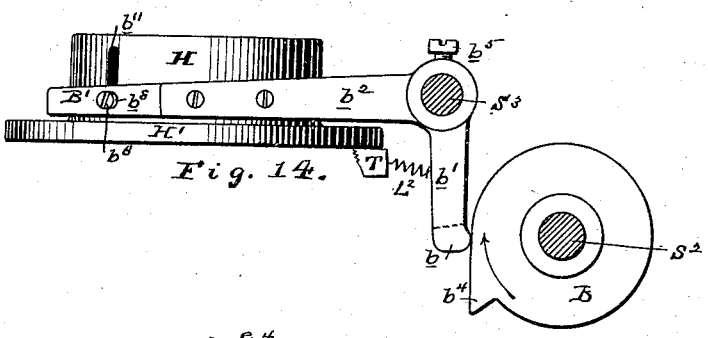

Fig. 14.

Fig. 15.

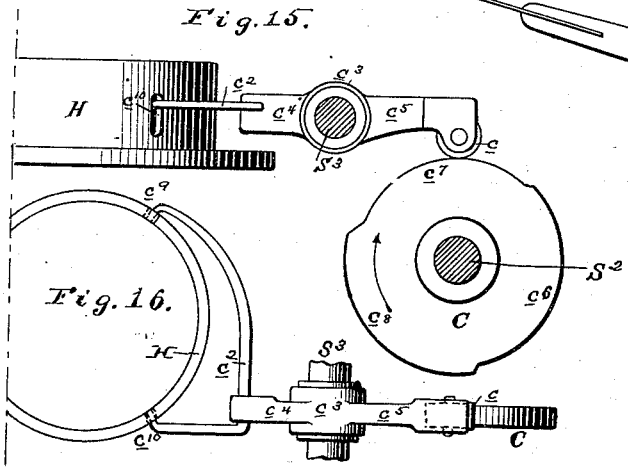

Fig. 16.

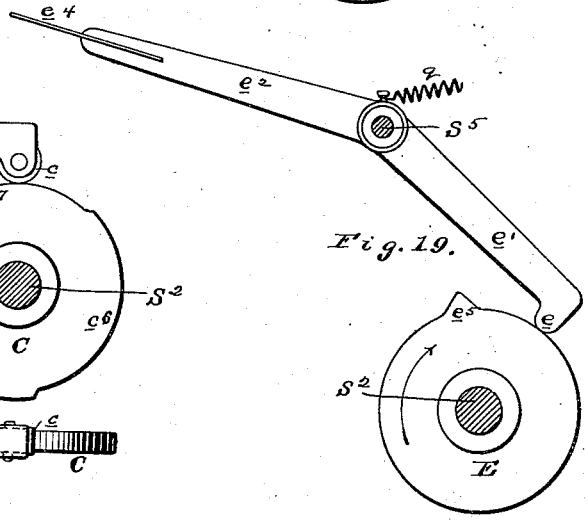

Fig. 19.

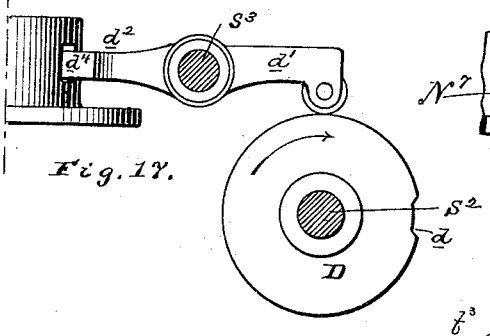

Fig. 17.

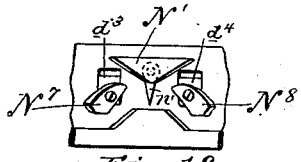

Fig. 18.

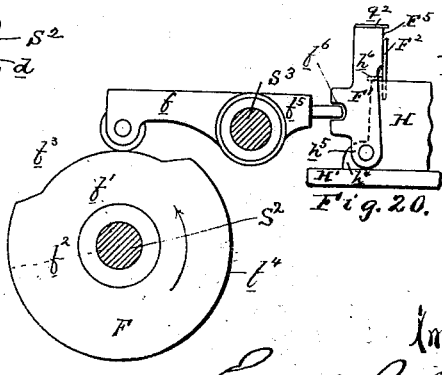

Fig. 20.

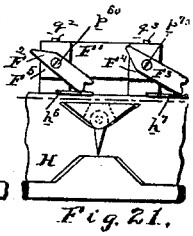

Fig. 21.

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(No Model.) 8 Sheets—Sheet 7.

E. R. BRANSON.

CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

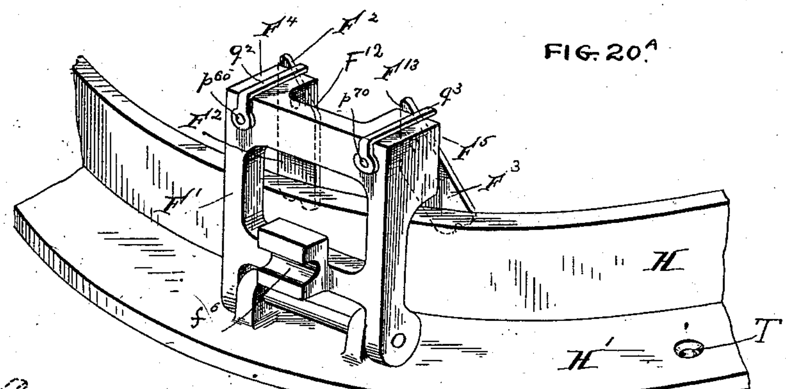

FIG. 20.A

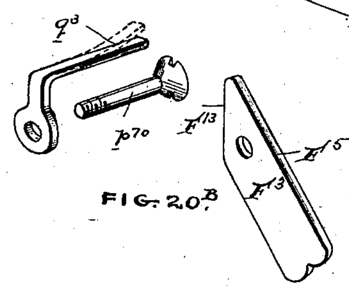

FIG. 20.B

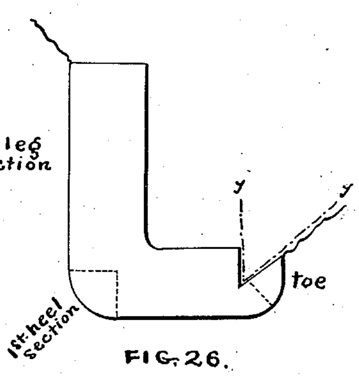

FIG. 26.

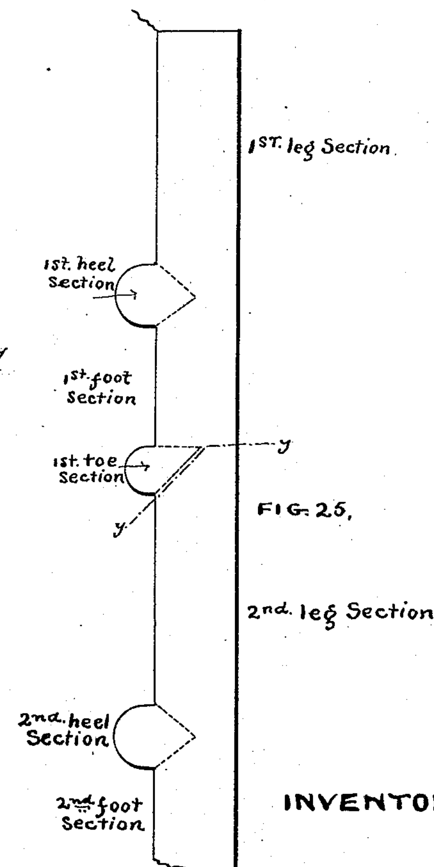

FIG. 25,

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CIRCULAR KNITTING MACHINE.

No. 553,277. Patented Jan. 21, 1896.

Fig. 23.

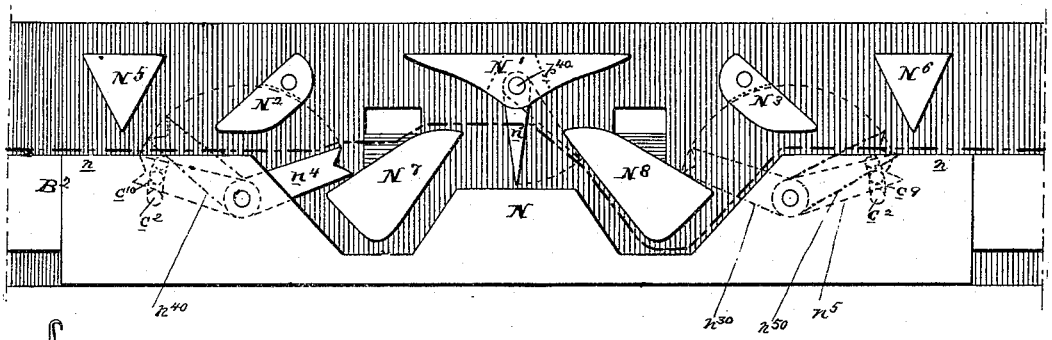


Fig. 24.

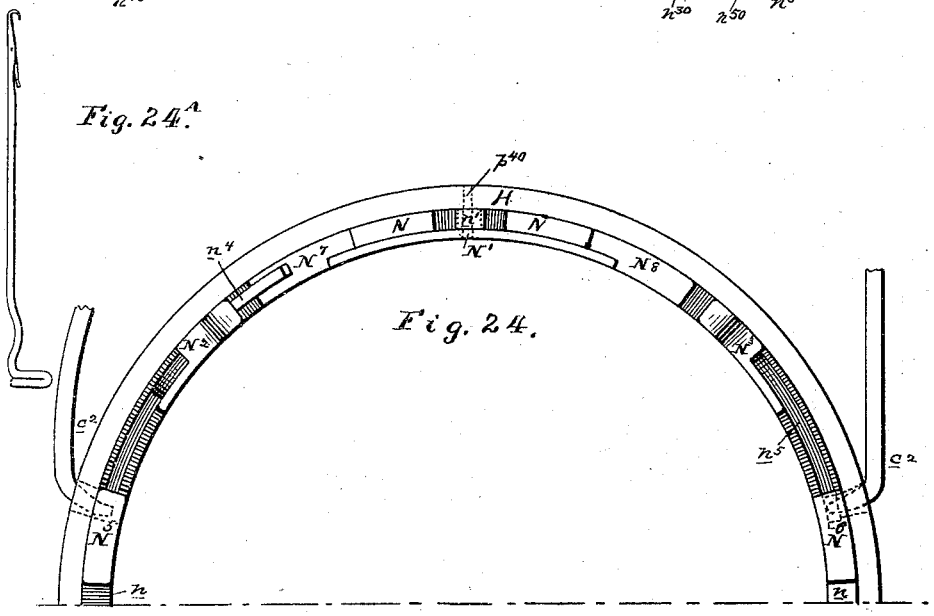
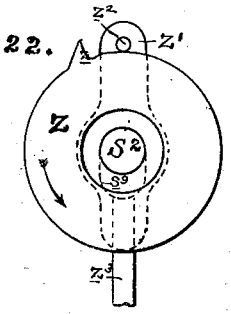


Fig. 22.



Attest:
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UNITED STATES PATENT OFFICE.

EDWIN R. BRANSON, OF PHILADELPHIA, PENNSYLVANIA.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 553,277, dated January 21, 1896.

Application filed May 5, 1888. Serial No. 272,967. (No model.)

To all whom it may concern:

Be it known that I, EDWIN R. BRANSON, a citizen of the United States, residing in the city and county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Circular-Knitting Machines; and I do hereby declare that the following is a full, clear, and exact description of the same.

Prior to my present invention knitting-machines of the class known as "circular" have been provided with mechanism for simultaneously lifting or throwing out of gear with their actuating-slots in the cam-cylinder a prescribed number—generally one-half—of the needles preparatory to "turning" the heel or toe of a stocking, during which operation the needles thus withdrawn retain their loops passively, while those not so withdrawn are actuated and knit as usual, the cam and needle cylinders being, however, at such times reciprocated instead of revolving continuously in relation to each other as they ordinarily do when engaged in producing the tubular web which constitutes the leg and foot of the fabric. These machines have, moreover, been provided with mechanisms by means of which the terminal needles of the row or series of those that do remain in action during the relative reciprocations of the needle and cam cylinders when turning are alternately and individually put out of operation, in order to effect the goring or narrowing of the web; also with other mechanisms by means of which the number of needles finally remaining in action can be augmented one by one, as it were, conversely bringing back into gear the terminal needles of the row or series which have been, as above mentioned, put out of gear, this being in order to "widen" the fabric.

Now the chief object of my invention is, in rendering the whole operation of the machine automatic, to establish a more positive connection and interaction of the parts, not only between the primary parts constituting the knitting-machine proper, but also between them and those which may be designated the "secondary parts"—viz., the "former" or pattern wheels and the "turning," "narrowing" and "widening" ancillary attachments—so that the whole may be united into a well-constructed light-running machine. Subsidiary to this it is my object to adapt and provide not only special and suitable mechanism for carrying out the individual features of this improved machine, but also to combine and mount the moving parts in a frame calculated to give an orderly and simple distribution to these various component devices, together with improved mechanisms for controlling their connection with the motive power.

In addition, my further objects are, in carrying these improvements into practice, to devise and construct an improved mechanism for reciprocating the moving cylinder, and preferably so as to impart a varying angular velocity to said cylinder—viz., a slow movement prior to and just after each reverse; to combine the same with an improved clutch mechanism for controlling said circular reciprocations of the moving cylinder, whereby it shall be started or stopped without unnecessary lash or lost motion, and always from a constant or fixed point in the relative movements of the main driving parts as they describe their functions; to devise and construct an improved controlling connection between the former-wheel train and the driving mechanism, so that the whole machine may be normally brought to rest upon the completion of the prescribed stocking or sock; and also so that during certain periods of rest occurring between the continuous and the reciprocating circular motions of the cylinders in the "head" of the machine said former-wheels and secondary cam-train shall be brought automatically into operation; to provide suitable mechanism therefor, and to disconnect and arrest the action of the same when, the several ancillary mechanisms having been put in train, they are, in their respective turns, to be withdrawn therefrom preparatory to the machine's resuming its ordinary continuous tubular knitting of the leg or foot, as well as in combining and connecting with the primary parts of the machine those mechanisms by which the secondary operation of turning, narrowing, and widening are accomplished in such a way as to adapt them to perform and repeat in substantially the same way and order their several functions when knitting a foot and toe, re-

spectively, as they originally performed them in the substantially similar duty of knitting the leg and heel; to provide improved mechanisms for carrying the same into practical effect; to construct the head of the machine in such a way that while the needle-cylinder is normally fixed and secured to a chuck or seat it may readily be detached, and, if need be, replaced by one adapted for finer or coarser work by having a greater or lesser number of needles, &c., and to devise and construct suitable mechanism therefor.

Lastly, my object is also in setting forth the specification for the above as a whole to at the same time describe and secure certain novel improvements among said several devices and mechanisms, which, while they may be taken as complete in themselves, are yet so far ancillary in making the specific machine described automatic that they may seem to have lost their distinctive characters as novel and useful features in other forms of construction were it not for this mention of my purpose of securing them in that aspect and the subsequent claims which aim at that end. Circular-knitting machines of this class (in which a hollow cam-cylinder "jackets" a concentrically-enveloped needle-cylinder having the above-described alternate, continuous, and reciprocating circular motions, whereby the knitting-needles are each in its own guide-slot reciprocated vertically by the engagement of their heels or offset lower ends in the slots of the cam-cylinder) being well understood, only as much of one of them provided with my above-mentioned improved devices is set forth and shown in the following description and drawings as serves to describe, distinguish, and connect therewith my invention; and in the light of that qualification, reference now being had to said accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts throughout all the figures, they will be found to illustrate the mechanism by which I have in practice attained the above-recited objects with the most useful results.

Figure 1 is an elevation of what I designate the "back" of a circular-knitting machine provided with my above-mentioned improvements throughout. In this view a portion of one of the legs X of the stand is removed in order to show the structural relation of the reversing-gear's clutch, of which hereinafter. Fig. 1^A is a detail view showing a modification of the driving mechanism in similar elevation. Fig. 2 is an elevation of the driving end of said machine, upon which there is carried the cylinder-reciprocating mechanism. It shows the parts external to the adjacent leg X of the stand, as well as an end elevation of the secondary or external cam-train and former-wheels, together with the preferred relative distribution from this point of view of these two mechanisms not only to each other, but also to the vertical head of the knitting-machine. For the sake of clearness, however, the driving-gear of the secondary cam-train and the main spur-gear of the continuous circular cylinder-rotating device are chiefly given in broken lines. A portion of the circular segment-rack U, with its intermeshing pinion U', is likewise thus represented; also one of the cams E, with its bent actuating rock-arm e'. Other parts, however, are not shown, as they, for the most part, lie back of, coincide in outline with, or otherwise would tend to confuse those already represented. Fig. 2^A is a detail view showing a modification of the mechanism for producing reciprocatory circular motion. Fig. 3 is a plan view, on a larger scale, of the machine, without indicating the legs of its stand. It shows the preferred distribution of the table, cylinder-head, secondary cam-train, and reciprocating mechanism. In this figure, also, the principal parts underlying the table T are indicated in broken lines, the more minute detail being reserved for other figures and descriptive matter. Fig. 4 is a rear elevation, partially in section, of the cam, cam-lever, and clutch mechanism governing the above-mentioned relative movements and temporary arrests of the needle-cylinder's rotations. Fig. 4^A is a detail view of a feature shown in Fig. 4. Fig. 5 represents a partly-sectional end view of a portion of the structure shown in Fig. 4, also showing a convenient method of attaching locking-pawls for opposing the ratchet-wheels W^6 W^7, shown in Figs. 2, 7, and 8. Fig. 5^A is an isometric view of the clutch, disks, and head-locking device. Fig. 6 shows a detail of a portion of the cam and slide-rod, with thrusting-lever for said clutch, as seen in plan. Figs. 7 and 8 are fragmentary views of the details of the devices for actuating the secondary cam-train and former-wheels in end and rear elevation, respectively. Fig. 7^a is a perspective view, shown fragmentary, of a modification of the secondary cam-train. Fig. 8^a is a side elevation, on a larger scale, of one of the wheels of the modified cam-train shown in Fig. 7^a. Fig. 9 is a vertical sectional elevation of the cylinder-head and miter-gear actuating mechanism, taken on the central line indicated by the dot-and-dash lines in Figs. 10 and 11. Fig. 9^A shows one of my detaching wedge-lugs, of which hereinafter. Fig. 10 is a plan view of the bottom of the needle-cylinder. This view in connection with Fig. 9 is especially adapted to show the spring-stud device by which I render the needle-cylinders not only normally securely fixed to their seats, but also, on occasion, readily detachable as well as interchangeable. Fig. 11 is a plan view of the top of the cam-cylinder, showing my improved needle-lifting rest and compact automatically-operated cam-train, for which purpose the needle-depressor attachment is removed. Figs. 12 and 13 are vertical sectional elevations of the two halves of said cam-cylinder, taken on the dot-and-dash line of Fig. 11. Fig. 14 is a side elevation of the cam-

cylinder, showing the external detail of the mechanism for lifting out of gear a number of needles simultaneously preparatory to turning as aforesaid. Figs. 15 and 16 are respectively a side elevation and a plan of a fragmentary detail of the mechanism for lifting out of gear individual needles for narrowing. Figs. 17 and 18 are, in relation to the cam-cylinder, respectively external and internal views of the mechanism for changing the length of stroke of the needles in their passage through the cam-train, forming an auxiliary tension device. Fig. 19 is a side elevation of the mechanism for throwing a large number of groups of the needles simultaneously and automatically back into gear preparatory to the resumption of continuous circular knitting. Figs. 20 and 21 are fragments respectively, external and internal, of the cam-cylinder provided with the mechanism for returning individual needles at each reciprocation of the needle-cylinder during the operation of widening. Fig. 20 also shows, as do Figs. 14 to 19, (saving Fig. 18,) inclusive, the cam-wheels and cam-levers of the secondary or external cam-train which throw their respective mechanisms, at designated intervals, in or out of gear. Fig. 20^{A} is an isometric projection of a portion of the structure shown in Figs. 20 and 21, having chief details offset, the point of view being approximately opposite the point of view from which Fig. 21 was taken. Fig. 20^{B} is a similar view of one of the depressor-tumblers with the spring q^3 and screw p^{70} therefor. Fig. 22 shows a detail of the cam and rider forming automatic belt shipper-bar actuating devices. Fig. 23 is a representation of a vertical side elevation of the internal structure of the cam area of the cam-cylinder developed upon a plane, showing details of the cams, and indicating in the dot-and-dash line the normal path of the needles' heels when passing from left to right through the cam system as shown. Broken lines indicate certain movements described and positions occupied by the needle-lifter levers and the swinging nose of the central depressing-cam when knitting continuous tubular web. The dot-and-dash outlines designated n^{30} n^{40} n^{50} are positions assumed by the tumblers n^4 n^5 when engaged in narrowing or goring the web, as hereinafter described. Fig. 24 is a plan view of said area of the cam-cylinder, showing detail. Fig. 24^{A} shows the form of needle best adapted to work in conjunction with the devices herein described and illustrated. Fig. 25 is a representation of a modified continuous tubular stocking fabric which the machine herein described can be adapted to produce. Fig. 26 shows an individual stocking-blank when severed and shaped from such continuous fabric as is shown in Fig. 25.

In the drawings the legs X X′, hanger X^2, table T, brackets or journal-housings O O, and cross-bars O′ Z^3, together with the pawl-bearing lug N^9, constitute the frame proper of the machine, the whole being rigidly secured together and carrying, in cylindrical bearings x x^2 x^3 x^4 of the leg X and hanger X^2, parallel cylindrical shafts S S′, of which S, being the power driving-shaft, is preferably fitted within its bearings with a fast belt-pulley W, (provided near its hub with a projecting tappet or stud w,) a corresponding but "loose" pulley W′, and fast spur-wheel V, and outside of bearing x there is secured to this shaft in the construction shown a crank s', provided with a crank-pin p^5, pivotally connecting therewith one end of a connecting-rod s, the other or outer end of which is provided with a knuckle s^2 and pivotally connected by a pin p^2 with an upright rock-arm R. The lower end of this arm is also pivotally connected near the foot of the leg X by a pin p^4, passing through its eye r', and preferably kept clear of the stand by a washer r^2, (see Fig. 1,) while the upper end of rock-arm R, extending above the summit of the circle described by the crank s', ends in another cylindrical eye through which a pin p^3 passes and serves, by means of the knuckle r^4, to connect it pivotally with a drag-link r, the other end of said link being pivoted by a pin p^4 to a circular segmental rack U, (preferably of the general form and contour shown in Figs. 1 and 2.) This rack is likewise pivoted upon a trunnion or boss x^5 formed on the outside of the leg X by a pintle P, so that the teeth of the rack, which are, as indicated in Fig. 1, cut upon the periphery of its arc, gear with a pinion U′, of which hereinafter. The rack U, like the rock-arm R, together with all the moving parts immediately connected therewith, is adapted to vibrate or swing in vertical planes—that is to say, substantially at right angles to the axes of the driving-shafts S S′. These parts may be dispensed with and a slider-crank substituted, as in the mechanism shown in Fig. 2^{A}, wherein U^{20} has a rigid middle member provided with a radial slot in which the crank-wrist of the crank s' is engaged and operates to vibrate said rack about the pivot P and drive the pinion U′ with a reciprocatory circular motion. This is a modification, however, which involves a sacrifice of the even angular motions of the former, being, as is well known, productive of a reciprocatory motion swifter in one direction than in the other. Otherwise it is equally practical in combination with the remaining mechanism.

The shaft S′ is provided between its bearings with a loose pinion-wheel V′ intermeshing with the spur-wheel V fixed to the shaft S. Between said pinion and the bearing x^4 it carries a face-plate or disk V^2, divided into two flanges of different diameters by a peripheral annular groove v^2, said disk being provided with a slot or keyway lengthwise of and in its eye, whereby the disk, engaging on a suitable key s^7 either integral with or driven into a seat in the shaft S′, as shown in Figs. 4 and 5^{A}, is prevented from revolving inde-

pendently of but remains free to move endwise along said shaft between the pinion V′ and bearing x^4, motion of this latter sort being occasionally communicated to V² by means of the thrusts offered it through the straddling leg v of a U-shaped slider-piece U², which is adapted to ride loosely in said groove v^2.

The shaft S′ is equipped, preferably outside the bearing x^4, with a substantially similar disk U³, provided with a corresponding groove u' and a keyway for a similar key s^8 fixed in shaft S′. The adjacent pinion-wheel U′, like its fellow V′, is secured from motions endwise of the shaft S′, upon which it is carried, either by means of its respective key's end s^8 and a plain collar or preferably by such a collar as either s^{20} s^{30}, respectively. (See outlines thereof in Fig. 5 and more fully in Fig. 4.) Said collars are fixed to the shaft S′ and provided with flanges u^{13} v^{13}, respectively, to each of which are secured by screws S^{97} and steady-pins S^{98} two or more circular segmental flange-clips S^{99} of the character best seen in Fig. 4^A. These clips being adapted to engage in annular grooves formed in the hubs of the pinion-wheels U′ V′ serve to maintain them loosely as regards radial motion, as well as in their working positions, without rubbing against the ends of their keys.

The inner sides of said pinion-wheels are further provided each with a hole u^{10} v^{10}, adapted to engage and register with studs P³ P² projecting equal distances from the adjoining sides of their respective slider-disks. One of these disks is also formed with a slot or gap J in the rim of the flange which carries said stud, the width of said flange being equal to the projection of said stud; and, adapted to work in connection therewith, there is secured to the bearing x^4 a fixed finger J′, so formed and located as to admit of the disk which has this gap to pass its inwardly-pointing finger-tip j, which is the converse male part of said gap in form and dimensions, laterally along the shaft S′ only when they two—viz., the gap J and finger-point—j are in radial alignment.

The slider U² has a suitable hole (represented in dotted lines in Fig. 4) through its connecting-body which, save for the spiral springs Q Q′, would permit it to freely slide on a bar S⁴ which, lying with its axis parallel to the shafts S S′, is itself also adapted to slide endwise through suitable eyes formed in lugs tt', bolted to the under side of the table T. Said slide-bar S⁴ is provided with certain abutments, as the washers v^5 v^6 v^7 and pins p^{20} p^{21} p^{22}, (shown in Fig. 4,) whereon the spiral springs Q, Q′ and Q³, with which it is helically wrapped in part react. It is also further provided with another abutment preferably made adjustable, as by the jam-nuts t^4 t^5 and washer v^8, Fig. 6, for the purpose of opposing the adjoining horizontally-swinging end of a cam-lever composed of two diverging arms A′ a, (see Fig. 6,) the swinging end of the longer of which, being preferably crotched and provided with disks a^{10} a^{11} adapted to embrace the shaft S⁴, as shown in Figs. 5 and 6, permits this lever to lie practically in the same general plane as the axis of the slide-rod S⁴, the whole lever A′ a being pivotally connected to the table T (see Fig. 3) on a downwardly-pointing pivot-pin P⁸.

The pivot P⁸ is conveniently formed, as shown in Fig. 5, with a main cylindrical shank terminating at its lowest extremity in a flat flange or head, which serves as a support to the lower side of said lever's eye, after passing through which said pivot is enveloped freely in a tubular washer or sleeve p^{87} reaching to the adjoining under surface of the table T, through which the pivot P⁸ then passes with a reduced diameter of stem, and its shoulder, banking against bottom of table T, establishes the relative distance therefrom of the pivot's above-mentioned head, and, taking advantage of a protrusion of said stem's upper end, I secure here to the upper side of the table T, by means of a screw-thread and nut on said pivot, as shown in Fig. 5, a hinge-bearing lug-piece N⁹, adapted to carry pawls P⁹ P¹⁰, which, extending outward beyond the back of table T, engage upon and lock the ratchet-wheels W⁶ W⁷ against accidental back slidings. (See Fig. 2.) Thence—viz., from P⁸—the shorter arm a of this lever passes and lies across in rubbing contact with the face of the secondary cam-wheel A, in which position the spring Q⁸, being normally under compression, is adapted to maintain it. Thus these two thrusting agents, in conjunction with the above-described gap J in the disk V² and the finger J′ bolted to the side of the bearing x^4, as above described, and shown in Fig. 5^A, define the position of the stud-bearing clutch-disks V² U³ in relation to the pinion-wheels V′ U′ and their respective driving spur-gears, as is hereinafter more fully set forth in the narration of their mode of operation.

It will be merely pointed out at this stage that as the reciprocating rack U and the revolving spur-gear V are concurrently in motion during all operations of the machine the connections "in" and "out" of gear between them and cylinder-shaft S′, which this clutch mechanism effects, take place when the pinion about to be engaged is already moving in the direction in which the cylinder driving-shaft S′ is to be itself then driven in. By this means lost motion is avoided between the intermeshing gear-teeth of the actuating spurs and pinions at the moment of beginning their actuating duty.

The spur-wheel V and the reciprocating rack U serve, when one or the other is connected through the gear-wheels V′ U′ on the shaft S′ to that shaft by the clutch, to impart to the shaft S′ corresponding motions; but as a great variety of mechanical equivalents may be substituted for a spur-wheel or a reciprocating rack, and also as many suitable clutches

could be substituted for the one specifically shown, I do not wish to be considered as limiting myself to the particular form of connections here shown.

Said cam-wheel A is fixed to a shaft S^2 carried in cylindrical bearings o^3 o^4 (see Fig. 3) of dependent arms projecting from and forming parts of the brackets O O respectively. The axis of this shaft lies parallel to that of shafts S S', and carries within its bearings what I have designated the "former-wheels" or secondary cam-train—viz., the cam-wheels B, C, D, E and F. Also upon a projection of shaft S^2 extending outside the bearing o^3 there are fixed the ratchet-wheel W^6 (provided with occasional higher teeth, as W^4 in Fig. 7) and the sliding-clutch's cam-wheel A; also, between these a loose or idle ratchet-wheel W^7, provided likewise with occasional higher teeth, as W^5, and, journaled upon a suitable eye, a bent-armed pendulous lever w', (see Figs. 1 and 2,) of which the dependent lower end is adapted to gravitate and rest normally against the front side of the power-shaft S, (see Fig. 2,) as well as within the range of the above-mentioned tappet w, while above said eye it extends upward and is provided on its side adjoining the ratchet-wheels W^6 W^7 with a pin p^6, Figs. 7 and 8. Upon this pin are pivoted pawls P^5 P^4, provided with upwardly-extending lugs, the ends of which being formed oblique are provided with detents or notches w^{10} w^{11}, into one or other of which the hooked edge of a curved plate-spring w^2 is adapted, on occasion, to register and engage. Said spring is secured to a convenient right-angled offset w^5 in which the oscillating tappet-lever w' here preferably terminates. In other cylindrical bearings o' o^2 (see Figs. 1, 2 and 3) in the brackets O O there is journaled parallel to the shaft S^2 a rock-shaft S^3. Also in journals o^5 o^6 paralleling and almost immediately over the former there is a second rock-shaft S^5. Both of these rock-shafts, it is to be noted, lie between the shaft S^2 and the cylinder-head H I. (See Fig. 2.) Upon these shafts are carried rock arms or levers adapted to come into contact with and play over and be actuated by the cam-bearing peripheries of the wheels B C D E F, as follows, viz:

First. A depending arm b', preferably of the form and contour best observed by taking Figs. 3 and 14 in conjunction, is fixed to and points downward from shaft S^3. An offset b in its lower end lies normally in contact with the periphery of cam-wheel B. Rigidly connected with arm b' by the shaft S^3 are two other inwardly-pointing lever-arms b^2 b^3, to the swinging extremities of which is secured a bridle B', loosely girdling the opposite exterior (front) wall of the cam-cylinder H. Said girdle is provided with screws b^8 b^9, which project not only through it but also pass loosely through ports b^{10} b^{11} in the cam-cylinder H, and thence extend toward and are screwed fast to a detached semicircular vertically-movable needle seat or rest B^2, as clearly shown in Figs. 11 and 13. Also upon the periphery of the wheel B there is formed a cam or buffer b^4, preferably of the profile shown in Fig. 14.

Second. Adjoining arm b', and loosely pivoted upon the rock-shaft S^3 by a suitable journal c^3, arms c^4 c^5 project, respectively, to the front and rear. Of these c^5 is the heavier, and preferably provided with a friction-wheel c, which, being at a proper place for that purpose, reposes by gravitation upon the adjoining cam-wheel C, which is provided with peripheral high and low levels c^6 c^7 c^8, as shown in profile in Fig. 15. Otherwise the outer arm, c^5, of said lever may be kept in contact with said cam-wheel under the constraint of a compressed spiral spring c^{59}, extending between the upper side of arm c^5 and the cross tie-rod O', as shown in Fig. 1. The inner extremity of the arm c^4 is provided with a bent whisker c^2, the ends of which, after spanning a proper angular distance on the cam-cylinder H, enter the same loosely through suitable port-holes c^9 c^{10}, Figs. 11, 15 and 16, and form seats, as hereinafter described, for the narrowing-needle lifters.

Third. Next to cam-wheel C, upon shaft S^2, there is fixed a cam-wheel D having a depression d in its otherwise unbroken circular periphery, as shown in side elevation in Fig. 17. Over this a rock-lever loosely pivoted by a suitable eye about the shaft S^3, and composed of arms d' d^2, likewise lies and plays. Of course the outer arm, d', has substantially similar equipments of friction-wheel and either spring or gravitation means of contact with cam-wheel D as the lever c^5 and cam C last mentioned had; but the inner arm, d^2, forks near the wall of the cam-cylinder and passes loosely through the same by openings or ports, as shown at d^3 d^4 in Figs. 17 and 18, the projecting inner ends thereof being provided with downcast stitch-cams N^7 N^8, of which hereinafter; and between cams N^7 N^8, I locate the nose of the downward-pointing **V**-cam N', preferably provided with a swing-point or switch n', as shown in Figs. 12 and 23.

Fourth. Fixed to the shaft S^2 is another cam-wheel E, provided with a projection or boss (shown at e^5, Fig. 19) on its otherwise circular periphery, and upon E the buffer-like lower end, e, of rock-arm e' plays. The upper end of said arm is rigidly secured to the rock-shaft S^5, from which shaft, and at right angles to its axis, two other rigidly-fixed lever-arms e^2 e^3 project under the upward constraint of distended spiral springs q, as shown in Fig. 2, and pass inward over the cylinders H and I. The ends of said arms, which in plan view lie, as it were, tangentially to the sides of these cylinders, are united by a thin flat plate e^4, Figs. 3 and 19, preferably of such an outline and size that it shall, during its vibrations, overlie the full number or more

of needles which the sliding rest B^2 above mentioned is calculated to raise or "lift," as hereinafter described.

Fifth. A cam-wheel F is fixed to the shaft S^2 and provided with high and low levels, the surfaces f^3 f^4 whereof are simply arcs described with radii of different lengths, f' f^2, and joined to each other by easy slopes. In contact therewith, and in manner substantially similar to that of cams C and D with their respective lever-arms, there is another rock-arm f, the inner part f^5 of which, as shown in Figs. 3 and 20, is fashioned into or provided with a fixed curved whisker, the end of which registers with and engages loosely in a slot f^6 in a backwardly-swinging forked flap-piece F' hinged at its lower extremities h^5 h^5 to projections h^4 h^4 on the adjacent exterior rear wall of the cam-cylinder H. This is preferably so that the center of form of this flap F' is approximately opposite the center of the cam system of the cylinder H.

Upon the upper or cross member of flap F' there are carried inwardly-projecting lugs F^4 F^5, to the flat inner faces of which pivot-screws p^{60} p^{70} support pendulous needle-depressor tumblers F^2 F^3, which when the flap F' is up in contact with the side of the cam-cylinder hang downward within the same and alternately present their notched or detent bearing lower extremities in the path of the offset heels of such of the knitting-needles as may be elevated out of range of the slots of their actuating cam system into their non-acting level—to wit, the dot-and-dash line of Fig. 21. Spring-catches for these needle-depressor levers are indicated in Figs. 20 and 21 at q^2 q^3, wherein h^6 h^7 also represent raised shelves or seats fixed to the rim of H, upon which F^2 F^3 repose when retracted. The whole attachment in its function, save for the novel automatic connecting device and the fashion and simplification of the depressor-levers and their retaining spring-catches, is one which operates, when in action, to the same end as the needle-dropping mechanism of kindred nature fully described in the United States Letters Patent No. 333,102 heretofore granted to me. Again, outside of the bearing o^4 the shaft S^2 extends and carries fixed upon it a wheel Z, Figs. 1, 3 and 22, the otherwise continuous even circular face of which is provided with a projection or stud z, having oblique faces, as shown in Fig. 22, while between said wheel Z and the bearing o^4 there is threaded on the shaft S^2 by an oblong hole s^9 a flat plate Z', provided on its upper part with a stud z^2 projecting at right angles over and resting upon the periphery of said wheel, whereon it rides idly save only when the same may in the course of its revolutions bring the cam-stud z into contact with it, as hereinafter described. The lower extremity of the plate Z' is also connected with or formed into a crooked depending rod z^3, which, passing through a suitable bridle or guide z', is pivoted to a shipper-bar Z^2. This bar passes horizontally across the legs of the machine—viz., from X' to X in Fig. 1—and is provided with slots z^9 z^{12}, adapted to allow said shipper-bar to slide endwise under the heads and along the stems of two shoulder-screws z^8 z^{11}, which, passing through these slots, are screwed at suitable intervals into an underlying fixed cross-bar Z^3. Of these slots it is to be noticed that the one nearest the rod z^3 after extending for a distance, preferably about equal to the width of the driving-belt, in a straight course parallel to the axis of said shipper-bar, thence extends in a zigzag having angles z^5 z^6 z^7, &c., forming, as it were, a capital letter W, sloping generally in the direction of the slot z^{12}, while the other slot z^9 is simply an elongated right-angled parallelogram upon which the shipper-bar can either slide endwise, as above described, or else, if swung in a vertical plane, oscillate and pivot. The shipper-bar Z^2 is further provided with a downwardly-projecting fork z^{10}, adapted to guide the driving-belt to the belt-wheels W W' in the usual way, while to and between the side or tine of said fork nearest leg X, and to said leg X, there is attached, under tension, a spiral spring L. The whole is shown in Fig. 1 in the position assumed at the outset of the knitting operation, where the screw z^8, being engaged in the terminal angle of the zigzag continuations of slot z^{12}, maintains the shipper with the fork z^{10} opposite to the fixed or driving-belt wheel W despite the sidelong pull of spring L.

Passing now to the head of the machine itself, Fig. 9 shows the method I prefer to employ in attaching the same to the table T—viz., by means of two annular flanges. One, H', projecting at right angles to the shell of the cam-cylinder, is fastened by screws T'' to the table T, the other, H^2, secured to the table T by means of suitable screws T' fitting in holes t^{10}. The other, H^2, passing downward through a suitable circular hole therein, is provided on its lower face with three or more tapped holes h, &c., into which screws h', &c., provided with inwardly-projecting clip-pieces h^2, &c., are screwed and support the annular chuck or cylinder socket I', so that it may revolve freely in its corresponding annular chamber h^3 formed for that purpose in the lower extremity of the cam-cylinder H. Said socket I', extending downward, terminates upon its lowest outer periphery with a miter-gear i, adapted to intermesh with and be driven by the teeth of the miter-gear s^3 carried upon the shaft S'. Internally, socket I' is chambered out into a right-angled annular chuck-seat i', into which the needle-cylinder I is adapted to fit snugly. I lock the needle-cylinder in position by means of the following device: Holes i^2 i^3 are formed radially and preferably diametrically opposite each other in the side walls of said seat. I also secure to and near the base of the inner wall of the needle-cylinder I a curved spring I^3, as by the screws indicated at m m' in Fig. 9. The ends

of said spring extending more than one hundred and eighty degrees and being of such a "set" that they may normally press against the adjoining shell of the cylinder I are provided with outwardly-projecting studs m^2 m^3, which pass freely through holes i^4 i^5, registering therewith, and pierce the shell of cylinder I. The length of the studs m^2 m^3 is such as to allow them, when forced outward by the spring I^3 through the shell of the needle-cylinder I, to project into the holes i^2 i^3 in the socket I', with which they also register and normally engage, but from which they can on occasion be disengaged and withdrawn by means of two downwardly-projecting pull-lugs M M'. These I preferably make of thin strips of metal inserted respectively between the adjacent wall of the shell I and the respective bearing ends of the curved plate-spring I^3, where they are normally maintained pushed flat against said wall until such time as they may be drawn farther down. (This "drawing down," it is to be noted, forms no part whatever of the duty of the machine so far as knitting is concerned, but is only for the purpose of either putting in a needle-cylinder when assembling the machine, or else in order to change one needle-cylinder for another; which, being desired to be done, said lugs are pulled down by hand until their involuted upper ends, acting as wedges, push the extremities of the plate-spring I^3 toward each other and retract the studs m^2 m^3 until they clear the holes i^2 i^3, respectively, when the cylinder is unlocked and may be lifted up and taken out of its seat I'.) In Fig. 10 the lug M is shown drawn down and the stud m^2 retracted, as is also the case in Fig. 9, while the lug M' is, in each of the illustrations, shown in its normal position with its end of the spring I^3 close to the wall and the stud m^3 protruding into the hole i^3.

All the remaining structure of the needle-cylinder being substantially such as is either well known or else constituting the subject-matter of aforesaid United States Patent No. 333,102, they are here passed by, merely referring to the fact that while Fig. 9 shows the summit of the needle-cylinder I capped by a row of sinkers I^4 of the general nature and character best adapted to work in combination with the remaining parts of the machine herein described, yet other sinkers adapted to work in conjunction with presser-wheels may also be used, if desired.

The cam-cylinder H, Figs. 9, 11, 12, 13, 14, 16, 17, 18, 20, and 21, is also, in general, of well-known type. Its flanges H' H^2 have already been described, together with the means of attaching thereto the needle-cylinder I. Likewise much of its external ancillary mechanism has already been minutely set forth in the preceding matter, so that all which now remains is to show the combination thereof, together with the preferred distribution of its internal mechanism. In doing this it will be observed, first, that the dot-and-dash line of Fig. 11 indicates the division of the cam-cylinder into what may be called the "knitting" and the "idle" zones. Of these the latter, the idle-zone, (designated as B^2,) is commonly known as the needle "rest" or "seat," along which the heels or offset lower ends of the needles normally slide in continual undisturbed succession one after another as they describe their course carried by their slots in the needle-cylinder. Said rest I form of a separate semicircular segment B^2 adapted to repose, as shown in Figs. 13 and 14, with the stems of the screws b^8 b^9 resting in the bottoms of their respective port-holes in the vertical shell of the cam-cylinder, and so B^2, by its upper surface, serves normally to connect into a continuous path the two ends of the actuating cam zone, (shown at n n in Fig. 12;) second, that into the half of the cam-cylinder H which lies between said termini n n, as shown in Fig. 12, there is compressed and adapted the entire needle-actuating cam system.

Save for the automatic actuating mechanisms combined therewith for the purpose of changing the length of the needle's stroke, or of bringing into or out of action, as the case may be, the "secondary" devices for throwing in or out of gear individual needles, or possibly the somewhat unusually short central return-cam N', with its recessed lower extremity and loosely-pivoted switch-point n', said cam system is substantially composed, first, of the ordinary cam-path for reciprocating the needles normally during continuous tubular knitting; second, of other avenues or by-paths, (the approaches to which are controlled by the secondary cam-train,) into which certain of the needles' heels are automatically delivered during the reciprocations of the needle-cylinder. Said by-paths are constituted by incorporating with the cams of the above-mentioned cam-path, first, pivoted needle-lifter tumblers n^4 n^5, acting in conjunction with fixed switch-cams N^2 N^3 for passing individual needles from the active to the non-active ranks; second, fixed outlying guard-cams N^5 N^6 for returning needles accidentally displaced to their normal level prior to their entering the actuating cam zone proper; third, automatically-movable downcast cam-lobes N^7 N^8 (best seen in Figs. 18 and 23) secured to the inner faces of the ends of their respective actuating-lever arms d^3 d^4 forming the auxiliary stitch-tightening device, and, fourth, on occasion—to wit., when F' is swung up into action—dependent oscillating depressor-tumblers F^2 F^3 acting in conjunction with laterally-extending free-standing wings of the central fixed cam N' to return non-acting needles into action, all of which devices, both in form and location, when associated as above referred to and as illustrated in the accompanying drawings, can be best taken up and explained during a consideration of their respective duties as they jointly or severally succeed and occur.

Therefore, passing now to the operation of

the whole as above set forth and combined, it will be seen that the various parts in operation act as follows: The shipper being placed as in Fig. 1, guides, by means of the fork z^{10}, an endless belt supplying motive power in the usual way to wheel W, from which it is transmitted by shaft S to gear-wheel V, which, by its intermeshing teeth, also revolves the smaller pinion-wheel V' with a more rapid continuous circular motion. This motion, the machine being now supposed to be upon the point of beginning its duty of knitting a stocking, is transmitted to the shaft S' as follows: The slider-disk V^2 being at this stage of the operation in its normal position—banked close against the side of the gear-wheel V', as shown in Fig. 1 and indicated in the dotted outline of the disk given in Fig. 4—the laterally-projecting stud P^3 entering into its corresponding hole in the side of the gear V' locks the two together radially and drives the shaft S' by the feather s^7; and the whole revolves together in the bearings x^3 x^4 and drives, by means of the feather s^8, the second slider-clutch disk U^3, which, under the constraint of the fork u of the U-shaped slider-piece U^2, is now held longitudinally near to the bearing x^4 and has its clutch-stud P^2 free of the pinion-wheel U', which (U') being loose upon shaft S', so far as regards radial motion, rides idle. Its longitudinal relation to U is correctly maintained by the inward-pointing flanges of the segmental clips of the fixed face-plate S^{30}. (See Figs. 4 and 4^A.) The shaft S' being connected in this way, revolves continuously and carries with it the hand-wheel s^2 and the bevel-gear s^3, which latter, gearing with the miter-teeth i, revolves the annular needle-cylinder socket I' and with it the cylinder which may have been secured thereto by the studs m^2 n^3. Said cylinder being equipped with needles as above mentioned, one of which is shown in Fig. 24^A, or with some other variety equally suitable, such as that shown in Letters Patent of the United States No. 333,102, granted to me on the 29th day of December, A. D. 1885, when thus continuously rotated, causes them to pass their heels successively along the upper surface of the cam-rest B^2, which rest at this stage of the operation is in its lowest position, (shown in Fig. 13;) for the cam-wheel B, Fig. 14, being still at rest, presents a part of its continuous circular periphery in contact with the buffer end b of the rock-arm b', as shown in Fig. 14, thus permitting gravity or a spring, as shown in Fig. 14 at L^2, to cause the lever-arms b^2 b^3, together with the needle-rest-actuating bridle B', to occupy at this stage their corresponding lowest position. From the upper surface of B^2 when in this position (also shown in Figs. 11 and 13) the needles' heels moving to the right or left, according to the direction in which the cylinder I may be revolved, cross the line dividing the knitting-zone from the idle-zone and pass on to and along the lifting-tumbler n^4 or n^5, as the case may be, which tumblers are now both in their normal position—that is to say, as they are to be placed preferably by the constructor on assembling the machine, viz., both as shown at n^4 n^{30} in Fig. 23—which is, in other words, lying so as to form a bridge or inclined way connecting the upper surface of the cam-zone designated n n and the adjacent cam-surface of the downcast stitch-cams N^7 or N^8, and thence said needles' feet pass successively to and up one or other of said cams, as the case may be—if N^7, in the path indicated in the dash-and-dot line of Fig. 23—until they reach its summit, from which the angular motion of the needle-cylinder swings them across the gap between said cam (say N^7) and the central depressing-cam N', under the lowest extremity of which they meet and swing the switch-point n' from its normal (perpendicular) pendulous position about the pivot p^{40} until it occupies the position indicated by broken lines in said Fig. 23, (also indicated in the dotted outline designated n^3 in Fig 12,) whereby the needles are forced downward as they are further swung onward toward the other stitch-cam N^8, (or N^7, if the knitting be carried on in the opposite direction, in which case also the point n' would assume the other dotted position, designated n^2 in said Fig. 12.) Along said cam they then move, as is further indicated in the aforesaid dot-and-dash line of Fig. 23, until having cleared its lowest extremity they are swung across the gap between it and the adjoining ascending portion of the fixed cam N, prior to meeting which, the first of them, when it encounters the remaining lifter-tumbler (viz., either n^4 or n^5, also inclined inward and resting against its adjacent stitch-cam as n^{30} rests on N^8 in said Fig. 23,) causes this lifter to revolve upon its pivot and take the position shown in broken lines at n^5 in Fig. 23, such position being allowed to either of these lifter-fingers by reason of the cam-wheel C being in its assembling position with its highest level c^8 in contact with friction-roller c, whereby lever c^5 is swung upon its fulcrum S^3 and the whisker c^2 is "on either hand" depressed toward the bottoms of the ports c^9 c^{10}, and these ports being formed so as to extend sufficiently far down toward the table T allow said whisker's inwardly-protruding ends to now lie so low that the needles' heels, passing from the active to the non-active cam-zone, can, uninterruptedly, move outward over such non-active tumbler—viz., one in the position shown at n^5 in Fig. 23—but should n^4 and n^5 not actually lie below the horizon of the upper surface N when thus turned outward the pressure of the needles' heels passing and thrusting them downward toward the rest B^2, I have found, is sufficient to raise the outer end of the lever c^5 by crowding said whisker c^2 still farther down toward the bottom of its port, and so force the back of such lifter-tumbler to the level of the needle-rest B^2, along which the needles are next again to successively pass. The vertical throws rep-

resented in the dot-and-dash line of Fig. 23 thus administered to the needles constitute what is easily recognized as the ordinary wave motion necessary to be imparted to their hook-bearing upper ends (see the needle shown in Fig. 24[A]) to operate in conjunction with any of the ordinary bobbin-rests, bobbins, tension and yarn-feeding devices with which the machine is presumably equipped; and when a tubular web of the prescribed length has been produced by their well-understood interaction to form the leg of the stocking the knitting operation of my improved machine then comes automatically to rest for a certain period by the intervention of pattern-wheels, and this as follows, viz: During every revolution of the belt-wheel W (see Fig. 1) the tappet w has struck and swung the rocking lever w' and thereby carried the pawls P^4 P^5 in an arc back and forth an equal number of times over the ratchet-wheels W^6 W^7, and as, at the outset of the knitting operation, these pawls are assembled so that the pawl P^5 has its detent w^{10} in the oblique face of the upper end of the lug w^3 free of the spring-catch w^2 (see Figs. 7 and 8) gravity then causes it to occupy substantially the position in which its companion pawl P^4 and lug w^4 are represented as occupying in said Fig. 7. Now, while in said position the nose of the pawl P^5 engaging the teeth of the idle ratchet-wheel W^7 drives said wheel by the space of, say, one tooth for each revolution of the shaft S; but said idle ratchet-wheel having now arrived at a point where one of its above-mentioned abnormally-high teeth (W^5 of Fig. 7) meets the pawl P^5 said tooth rotates the same through such an arc upon its pivot p^6 that the upward-extending lug w^3, sliding its wedge-like upper surface under the edge of the plate-spring w^2, lifts said spring until first the notch w^{11} of the lug w^4 of the pawl P^4 is disengaged; then, second, when said high tooth W^5 has passed from under, pawl P^5 "hooks" itself "up" on said catch-spring w^2 by engaging the downward-turned edge thereof with its own detent w^{10}. Meanwhile gravity acting upon pawl P^4 drops it into action on the driving ratchet-wheel W^6, and the shaft S^2, hitherto motionless, begins to receive from the pawl P^4, with each revolution of the belt-wheel W, an intermittent circular motion, whereby it will be seen that the wheels W^6 W^7 are not only a means of communicating intermittent movements, but also in point of fact are pattern-wheels as well—that is to say, the function of these fast and idler ratchet-wheels is, in accordance with the pattern, to alternately and automatically "put in motion" or again to "leave at rest" the shaft S^2 carrying the former or pattern wheels or secondary cam-train. For example, if the pattern of hose to be knit calls for a leg having five hundred and fifty rows of stitches a number of ratchet-teeth equal to the number of impulses which the tappet w delivers to the lever w' during the operation of revolving the movable cylinder five hundred and fifty times is counted off upon the teeth of the idle ratchet-wheel. The count commences from the tooth initially registering with the pawl P^5, and then a "higher" tooth is introduced. When the back of this tooth is automatically brought by action of the tappet-lever and consequent advances of the idle ratchet-wheel W^7 underneath its pawl P^5, it will not only effect the throw-off and latching out of gear of that pawl, as above described, but it will simultaneously release and bring into operation the previously non-active pawl P^4, and thus cause the tappet-lever w' through the medium of the fixed ratchet-wheel W^6 to set the secondary cam-train in motion. This done, certain of the secondary cams operate, as hereinafter fully described, to modify the normal action of the machine, and then, as soon as these cam-wheels have been driven by the ratchet-wheel W^6 through a sufficient arc of revolution to accomplish their present duty, the tappet having also brought said "fixed" ratchet-wheel at the same moment to a position where it presents a "pattern" or higher tooth than its ordinary series within range of the tappet-pawl P^4 as it swings back to take a new actuating-stroke, then this tooth by lifting it higher than usual puts that pawl back out of gear; and locking it upon the tappet-lever spring-latch simultaneously for the coming stroke drops into gear upon the idle ratchet-wheel the other pawl P^5, and this wheel recommencing from the high tooth which lately put it out of gear is driven idly while the pawl P^5 counts off upon its periphery a tooth for each forward stroke of the tappet-lever toward its own next higher tooth, which, in conformity with the pattern, is also contrived to be distant just as many teeth as there are strokes of the tappet to be made before the secondary cam-train shall be again required to act in any of its various functions; but, as soon as that occurs, another higher tooth of the idle ratchet-wheel meets its pawl P^5 and a shift of the ratchet-pawls takes place automatically, and so on. By this means I accomplish the duty of actuating the secondary cam-train only as is required in conformity to the pattern, and that by a very compact mechanical arrangement. By this means—viz., alternating the thrust of tappet-lever w' between a loose wheel, as W^7, and a wheel, as W^6, which is fixed to the drive-shaft S^2 of the secondary cam-train—I accomplish the duty of actuating said secondary cam-train only when, in conformity to the pattern, the same is required to be in action. It is, moreover, a very compact mechanical arrangement, to-wit: By it I am able to make intermittently-actuated cam-wheels of comparatively small diameter take the place of more cumbersome and practically continuously-actuated devices, of which sort of devices there is an illustration in Fig. 7[a], wherein, in place of cam-wheel B, there are placed, within range of a cam-reading-lever end b',

such as is shown in Fig. 14, a cam b^4 fixed at proper intervals to the face of an endless chain b^{100} rove upon a sprocket-wheel B^{100} fixed to shaft S^2; and for operatively connecting said cam-chain modification to the general driving parts of the machine a substantially continuous rotary driving mechanism is indicated in Fig. 7^a by the outline of toothed wheel W^{600}; and an actually continuous one is shown in the same view by the sprocket-wheels W^{100} W^{200} and chain W^{300} connecting shafts S and S^2. The rotation of the cam or pattern wheel A brings it from the position of having the lowest part in its periphery—viz., a^3—in contact with the bent arm a of the lever A′ into that of having the arm a forced outward by the adjoining incline or cam which connects said lowest part a^3 with the slightly higher circular portion, (designated a^4 in Fig. 5.) This passage of the arm a from surface a^3 to a^4 forces the lever A′ to revolve horizontally through a small angle, upon its pivot, in the direction shown by the curved arrow near said pivot P^8 in Fig. 6, and by said movement to thrust its disks a^{10} a^{11} against the abutment v^8 and force the slider-rod S^4 not only endwise through the lugs t^2 t^3, but outward toward the hand-wheel s^2, thereby compressing the springs Q^3 and Q′ between their respective abutments—viz., Q^3 between v^5 and the adjoining face of the eye t^2, and Q′ between v^7 and the adjoining side of the eye t^3. The spring Q is also by this same motion of the rod S^4 compressed between its abutment v^6 and the adjoining end of the slider U^2, and so forces said slider in the same outward direction as the rod S^4 moves in. (See Fig. 1.) In addition the slider U^2, by the sidewise drag of the straddling legs u v on the flanges of the grooves v^2 u', respectively, carries with it the disks V^2 U^3 along the shaft S′ and keys s^7 s^8, respectively, and by so doing causes the stud P^3 to begin to be retracted from the hole v^{10} in the pinion V′ until, while it is still partially inserted therein, its further retraction is temporarily arrested by reason of the inwardly-turned tip j of the stationary finger J′ coming into contact with a part of the adjoining side of the larger flange of the said disk V^2, and against this flange the tip j now continues to rub until the pin P^3, which is still locked to and driven by the pinion V′, turns the disk V^2 so that the gap J comes into alignment with said tip j. Then as soon as that takes place the spring Q, pressing against its fixed abutment v^6, forces the slider U^2 still farther in the same outward direction until the disk V^2, sliding its gap J over, finally envelops the finger j, thereby locking not only itself, but also, by the agency of the key s^7, the shaft S′ from rotary motion. At the same time the complete releasing of the stud P^3 from the hole v^{10}, which takes place concurrently with and by virtue of said lateral thrust of the spring Q, permits the pinion V′ to run idly about the now motionless shaft S′. Thus all parts which previously derived their motion (including the head H I, &c.) from shaft S′ come not only to rest, but also, as often as this part of the operation may be repeated, to rest in precisely the same relative alignment; but, since the belt-wheel W is still revolving, the pawl P^4, continuing in action, drives the secondary cam-train, and in it the cam-wheel B now comes into operation—that is to say, during this arrest of the knitting operation the cam b^4, projecting from the wheel B, (see Fig. 14,) is revolved against the buffer b and causes it to rotate the shaft S^3 through such an arc that the arms b^2 b^3 (attached thereto) rise from the position shown in Figs. 2 and 14 until the screws b^6 b^7 (uniting the bridle B′ and the needle-rest B^2) are forced upward to the tops of the ports b^{10} b^{11}, in which position they cause the needle-rest B^2 and all the needles which may then be reposing their feet upon it to come above the active level of the cam-train in the cam-cylinder H—viz., to the non-active level designated by the dot-and-dash line in Fig. 21. The cam b^4 is preferably of the form shown in profile in Fig. 14—to wit, consisting of an easy incline—the cam proper and a radial connecting-surface leading back to the otherwise continuous circular periphery of the wheel B, whereby the buffer b, having once been acted upon and passed by said incline cam b^4, it immediately, under the action of gravity or the aforesaid spring L^2, swings back into its normal position of contact with said circular periphery of B. Thereby the needle-rest B^2 under the attachment of the screws b^8 b^9 is also dropped back into the position shown in Fig. 14; but the needles which were raised by it are maintained in the usual manner by the friction of the stitches and a compress-girdle encompassing their shafts in the ordinary way in the annular groove I^5 of the needle-cylinder I (see Fig. 9) and remain for the time lifted out of gear. At the same time the aforesaid action of pawl P^4 and ratchet-wheel W^6, having brought the notch connecting the levels c^8 and c^6 of the cam-wheel C not only under but clear of the friction-roller c, has permitted gravity to drop said roller c from the previous position which it was maintained in on the high level c^8 of the wheel C to the next lower one c^6, and thereby lifting the whisker-bearing end c^4 through a sufficient angle causes the inner ends of the whisker c^2 to rise in the ports c^9 c^{10} and raise the recumbent lifter-tumblers, or rather that one of them which is then turned outward, as n^5 in Fig. 23 is, so that it (and also its fellow, n^4, when that one subsequently becomes turned into a corresponding prone position) is lifted at its free or swinging and notch-bearing extremity so far above the level of the normal needle-path (see n^4, Fig. 12) that the heel of the first needle which swings along it in inward direction—viz., from N^2 toward N′—may be caught in and engage with the same, to the end that as it is further swung onward by the needle-cylinder in its

now reciprocating rotating motion said needle may be, first, deflected and carried in an upward arc until its heel is discharged (preferably while still ascending) upon the overlying inclined way formed by the slanting upper side of the fixed cam N^2, whereby it is, second, shunted up into the non-active level above the cams, and, joining the ranks of those that had previously been placed in a similar condition by the above-described action of the sliding needle-rest B^2, it also remains out of action for the time being. All of this operation, save the automatic seating, of either of the lifter-tumblers n^4 or n^5 is well understood and fully described in my aforesaid United States Patent No. 333,102. Then after said duty by the cams B and C the shaft S^2, by a still further partial revolution, (see Fig. 5,) causes the highest level a' of the wheel A to come opposite the arm a. In doing this the incline surface connecting the levels a^4 and a', acting as a cam, again pushes said arm a farther outward from the shaft s^2 and swings the lever A' still farther in the direction indicated by the curved arrow in Fig. 6, and makes the lever, in substantially the same way as it previously acted, shove the slider U^2, with the parts connected thereto, not only in a continuation of the same path and direction which was previously given them until said disk V^2 clears its gap J of the finger j, but also moves the other disk U^3 so far toward the pinion U' that the stud P^2, having first come into contact with and banked against some part of the adjoining side of this pinion U', remains milling there in rubbing contact until the same has revolved sufficiently about the shaft S' (upon which it had, up to this stage, ridden idly with a reciprocating circular motion imparted to it, as hereinafter set forth) to bring the hole u^{10} into registering alignment with the aforesaid stud P^2. Then that stud entering therein, by means of the disk U^3 and key s^8, locks the pinion U' to the shaft S', substantially as shown in Fig. 4. The necessary additional lateral throw of the slider U^2, requisite for the above-described entering of the stud P^2 in hole u^{10} when the two are thus brought into alignment, is furnished the slider U^2 by the spring Q thrusting against the abutment v^6, which is, in its turn, banked by the slide-rod S^4 forcing its other abutment t^5 t^4 v^8 against the now stationary disks a^{10} a^{11} of the arm A'.

Referring once more to the shaft S, it will be seen on inspecting Figs. 1 and 2 that it has, during every revolution of the belt-wheel W, caused the rock-arm R to vibrate back and forth upon its pivot p' by means of the crank s', pivot p^5, knuckle s^2, and pin p^2. Said vibrating arm R, it will also be readily understood, has a varying angular velocity imparted to it by the connecting-rod s, to wit: One which is swiftest when said rock-arm R is passing a line drawn vertically through its point of oscillation, (the center of the pivot p',) and slowest, just as it either approaches or leaves the lateral limits of the circular arc through which it swings; or, in other words, slowing to its movements of reversal; and as the pivot p^3 connects the upper end of said arm R by means of the knuckle r^4 to the drag-link r, said link has also been thereby reciprocated back and forth in curves a number of times equal to the revolutions described by said main driving-shaft S, by the pin p^3, and caused the segmental toothed rack U to oscillate to and fro upon its pivot P a similar number of times; and its teeth intermeshing with those of the pinion-wheel U' have imparted to it a reciprocating rotary motion of correspondingly varying angular velocity upon the shaft S'. This, as aforesaid, has been merely an idle function while V' was in the position relative to the slider U^2, (shown in Fig. 1,) but which, on the coming into contact of the stud P^2 and the side of said pinion U', has, as above described, served to first align said stud with the hole v^{10}, and, second, when they were coupled together to then impart, by virtue of the disk U^3 and key s^8, the peculiar rotary motion which it now has to the shaft S', and by it through the miter-gears s^3 and i to the needle-cylinder I. Moreover, at the time when the stud P^2 enters the aforesaid hole u^{10}, the original assembling of the various parts of the machine having been calculated so that the pinion U' shall be at said moment intermeshed on the central portion of the segmental rack U, the first movement imparted to the cylinder I by the revolution of the crank s' is to cause the needle-cylinder to take exactly one-half of a complete revolution (the number of teeth on the rack and pinion respectively being adapted to impart that much angular motion to such needle-cylinder by such a swinging from said central point of the rack to either end of its throw) and by this half-revolution to cause all the needles that were left (after the action of B^2) in the active zone to move practically uninterruptedly outward over a needle-lifter tumbler in the latent position indicated by dot-and-dash line at n^{50} in Fig. 23, and come momentarily to rest with their heels upon said needle-rest B^2. From this position they pass, by the succeeding reciprocations of pinion-wheel U', as above mentioned, to and fro through the cam system and lose their terminal needle with each passage of the cam until finally they arrive at the desired point, say when one-sixth ($\frac{1}{6}$) of the whole number of needles with which the cylinder I may be equipped remain in action. Then the designated time for "turning" the heel having arrived, the wheel C further revolving causes the roller c to fall from the level c^6 to c^7 and assume the position shown in Fig. 15, in which the whisker c^2 raises the lifter-tumblers' points of repose sufficiently high to elevate their entire notch-bearing ends above the level in which the needles' feet sweep along n n, as indicated at n^{40} in Fig. 23. This causes the first needle

which meets with either of them thus elevated as said needle passes from the needle-rest B^2 into the cam area of the cylinder H to swing said tumbler about its pivot and leave it in the position shown at n^4 in Fig. 23—that is to say, the tumblers are made to automatically reassume the primary function of bridges leading to their adjoining stitch-cams N^7 or N^8. This takes place without deflecting said first needle, which thus met the lifter, from its normal path—the dot-and-dash line of Fig. 23. Concurrently with this reversion to the normal arrangement of the cam system of the cylinder H the shaft S^2 also brings the high level f^4 of the cam F from under the friction-roller bearing end of the lever f and thereby rotating it upon the axle S^3 raises f^5 and swings the hinged flap F′ up into the position of contact with the external wall of cylinder H, as shown in Fig. 20, thereby bringing the upper ends F^4 and F^5 thereof not only above and within the upper rim of said cylinder, but also causing the depressors F^2 F^3 to slide forward, and clearing the shelves h^6 h^7, under the influence of gravity, to come into range of such of the needles' heels as are now in the non-active level indicated in the dot-and-dash line in Fig. 21. These depressors thereupon, during the still continued reciprocations of the cylinder-head, begin and continue to act with their notch-bearing lower extremities, as follows, to wit: It is to be noted that these depressor-fingers (shown in Figs. 20 and 21) are substantially alike in shape, but assembled so that their beveled upper portions fall inward toward each other as "rights and lefts;" that they both terminate upon their upper and unnotched extremities in rounded summits, while their inner or adjoining parts thence slope away in oblique faces F^{12} F^{13} extending downward approximately to the level of their points of suspension on the pivots p^{60} p^{70}; that otherwise their sides are substantially parallel and equidistant from said pivots; that immediately above said pivots the set-springs q^2 q^3 are located, the inwardly-projecting free ends of which lie in range, respectively, of the arcs described by said depressor-fingers' rounded summits whenever they may be swung past them, the said springs q^2 q^3 being constructed of such a stiffness as to prevent either of said fingers passing under them by virtue of the momentum they may acquire in falling by themselves from, say, a horizontal to a perpendicular position in either direction. The objects of these arrangements are that F^2 F^3 can be so brought into action that while one of them lies inclined toward the direction in which the way-going series of non-active needles shall first approach them, yet the other then hangs straight downward, whereby it is obvious that they thus extend their notch-bearing lower extremities to different levels in the cam-cylinder H—to wit, that one which now banks its oblique face against its spring-catch, being substantially perpendicular, hangs deeper down; and, on either hand, presents its straight flat sides in the non-active level—the dot-and-dash line of Fig. 21—while its mate, F^3 of said figure, banking the upper portion of its outer flat side against its catch-spring, (the length of both F^2 and F^3 being not only the same, but also proper for such purpose,) hangs at an angle calculated to bring its notch-bearing extremity into range of the non-active needles' heels, the first of which heels, meeting said notch, is swept in a downward arc and delivered to the under side of the adjoining free-standing wing of the central depressor-cam N′, which leads said needle into the normal cam-path. Meanwhile, the next succeeding needle's heel, meeting the side of this depressor-finger and swinging it farther onward, forces its summit under the overlying catch-spring. Then, when all the following needles have ridden under it, said depressor drops back and reposes with its oblique face against its catch-spring, and thereby said depressor-finger becomes, as it were, temporarily idle—that is to say, idle until after it be swung, by the return of the needle-cylinder, back to its active or angular position, substantially as its mate is now forced by what has become the leading non-active needle, when its heel (meeting F^2, similarly hanging straight down) bears against said depressor's flat inner side, and rotating it under the overlying spring-catch q^2, suffers it, on the subsequent passage of the whole non-active series of needles' heels from under it, to drop back and repose turned outward with its notch lying in wait at its operative angle for the non-active needle's return. Such position is defined by virtue of the straight outer side of said depressor-finger then banking against q^2, so that when these needles again return from the idle-zone by the reciprocations of the cylinder I they then cause each of these depressors to perform substantially the same act or duty which its mate went through on the last prior passage; and so on, alternately active and passive, the depressor-fingers put back into gear single needles and thereby cause the fabric to "turn and widen." Said widening is continued until such time as the machine's head is brought by the revolution of the driving parts to a second period of rest. This occurs by the wheel A which is rotated by shaft S^2 (a high tooth on wheel W^7 once more putting pawl P^4 in action) now being brought so that the high level a', passing from in front of the lever a, allows it to be forced by the springs Q^3 Q′ against the next adjoining lower level a^2; and in consequence to allow said springs to retract the stud P^2 from the hole w^{10}, and then subsequently to hook the finger-tip j into the gap J, (substantially in the converse way that said two parts were before brought into conjunction when u^2 was thrust in the opposite direction by the lever A′.) Said engagement now similarly locks the head driving mechanism in the predetermined and constant alignment, and al-

lows the wheel E to force its cam e^5 under the extremity e of the lever e', and by the consequent partial revolution of the shaft S^5 to depress the arms e^2 e^3, and with them the flap e^4, which, coming down upon the heads of such needles as may now be left non-active, forces them down their respective slots in the needle-cylinder until their heels once more repose upon the needle-rest B^2. Then the cam e^5 having cleared the buffer e the spring q retracts the whole system, e^4, e^2, e^3, S^5 and e' e, back into the position shown in Figs. 2 and 19. Moreover, during the last reciprocation of the head as aforesaid, while the non-active needles had their heels under and supported the depressor-fingers F^2 F^3, the shaft S^2 brought the cam F so that the high level f^4 was forced by the incline or cam surface connecting said level with low level f^3 under the friction-roller bearing end of the lever f, and consequently, depressing f^5 caused the flap F′ to drop back and retract the depressor-fingers F^2 F^3 from their active position to that of repose on the shelves h^6 h^7, as shown in Fig. 21. After the widening has been finished to complete the heel the cam C is turned to such a position that the roller c rides on the portion c^3 of the cam and the tumblers n^4 n^5 are dropped to their lowest position out of the way of the heels of the needles; but before completing the description of their operation I take this opportunity to state that while I have, in most of the several mechanisms hereinbefore set forth, described and shown only that form which I preferred for each instance I do not mean to thereby disclaim the right to attain my objects by the substitution therefor of equivalents operating, whether singly or conjointly, in substantially similar ways to the same ends. However, as a distinct and separate modification of the driving mechanism, I do hereby point out that power may also be advantageously applied, especially with a comparatively high-speed belt, through the pinion-wheel V′ without changing its position in relation to the spur-wheel V. This is as follows—to wit, by substituting, in lieu of the fast and loose belt-wheels W W′, two loose belt-wheels W^{20} W^{30}, journaled upon the shaft S′, as shown in Fig. 1ᴬ. In this modification it is to be noted that the wheel W^{20} is rigidly secured to or formed integral with the pinion-wheel V′, and, when actuated by the belt, becomes the main driving agent; also, that the train composed of spur-wheel V, shaft S, crank s', pitman s, rock-arm R, link r, and toothed rack U, instead of driving is, in this combination, employed merely as a driven velocity and motion-changing device; furthermore, that with the removal of the belt-wheel W and consequent loss of the tappet w, the oscillating tappet-lever w' would become motionless; but this I readily prevent by means of locating said tappet on the spur-wheel V, as indicated in dotted outline at w^{20} in Fig. 1, and then by bending or otherwise adjusting the parts so as to bring the lower member of the lever w' within range of it.

For the purpose of knitting hosiery continuously, one stocking immediately after another without break, for which my present improved machine is well adapted, I prefer to employ this last-mentioned modification of the driving mechanism in combination with the rest of the machine, substantially as herein described and illustrated, save only that I then either disconnect or wholly remove the belt-shipper bar Z^2, and for that reason have given Fig. 1ᴬ divested of it. In this case, while it may seem a departure from the preceding specified object, the fabric produced, consisting of a series of leg-sections, heel-bags, foot-sections, and toe-bags successively repeated, substantially as illustrated in Fig. 25, affords upon cutting apart, as it is well understood among hosiers, stocking-blanks, such as are illustrated in Fig. 26, and these only differ from the sort that the machine with its belt-shipper attached produces in the fact that the blanks when cut from the continuous fabric have to be finished at their tops as well as to have their toe-section united; and therefore, lastly, remarking that the cams N^5 N^6 of Fig. 12 are placed within the cam-zone of the cylinder H not merely for the purpose of returning the heels of any needles which, either by an untoward stiffness of the lifters n^4 n^5 or any other similar accidental cause, may have been, at any time in the knitting operation, lifted above the normal level of the needle-rest B^2, back to the upper surfaces of n n, but also for the purpose of giving the needle-rest B^2 freedom for its automatic movements. I now proceed to point out that the wheel A, once more, under the continued revolution of the shaft S^2, which, it is to be borne in mind, is now in motion, brings its lowest level, the notch a^3, into a position opposite the arm a, as in Fig. 5, against which level springs Q^3 Q′ immediately thrust said arm; and also, by this thrusting, cause the disk V^2 to clear the finger j from its gap J, and thrust the stud P^3 into rubbing contact with the adjoining side of the pinion V′ and there remain until it, milling idly about the shaft S′, first aligns with and then enters the hole v^{10}, and brings the machine once more into substantially that functional condition in which it was described as first being, save only that the "higher" or pattern-teeth of the fixed and idle ratchet-wheels W^6 W^7 are now arrived by their mutual interactions at the commencement of those portions of their spacings upon which the higher or pattern-teeth are laid off with reference to the numbers of rows of stitches in the stocking's foot, and also save that the cam z upon the cam-wheel Z, being carried by the shaft S^2 in a position very slightly in angular advance of the radial notch connecting the intermediate (a^2) and lowest (a^3) levels of the change of motion cam-wheel A, it, (the cam z,) just prior

to this apparent reversion having first rotated under the stud Z^2, lifts that stud upon its back, and then the rod Z^3 moves the shipper-bar upward. This causing the banking-screw Z^8 to clear the terminal notch of the zigzag aperture in which it had hitherto reposed, as shown in Fig. 1, the shipper-bar is then drawn sidewise by the pull of the spring L—that is, it is pulled toward the leg X until the shank of the screws Z^8 fetches up and arrests this movement by engaging in the adjoining notch Z^6. To this engagement the immediately-following drop back of the stud Z^2—as the shaft S^2 continues to revolve upon the circular periphery of the cam-wheel Z—the gravitation of the shipper, its pivotal connection at Z^{11}, and the upward inclined slope of the walls of the zigzag, which connect the notches Z^7 and Z^6, all co-operate. Now in this position, while the fork Z^{10} has begun to pass toward the idle-wheel W', it still delivers the belt to the fast driving-wheel W and remains doing so until the next revolution of the secondary cam-train, as hereinafter set forth.

If at any time during any of the aforesaid knitting operations it is desired to tighten or loosen the stitch, I further combine with said machine the device shown in Figs. 17 and 18, in which the cam-wheel D, being secured at a proper part of the shaft S^2 and having suitable high and low levels (see d) in its otherwise circular periphery, actuates thereby, on such occasion, the lever d' and thus swinging the inner ends of $d^3 d^4$ simultaneously, raises or lowers, as the case may be, the lobes N^7 N^8, which are attached thereto, (see Fig. 18,) thereby causing the needles' heels to take unusually long or short throws and correspondingly loosening or tightening the stitches which they make. After the resumption of the original working, the machine continuing in operation and knitting a tubular web, forms the foot of the fabric. This foot completed, a high tooth, as W^4, having put an end to the activity of the secondary cam-train at the commencement of said second tubular knitting in the way which is now obvious, the original high tooth W^5 repeating its first action, now brings shaft S^2 into activity once more, and makes said secondary cam-train perform and actuate the parts generally connected therewith in precisely the same order and way in which they acted in their first revolution as aforesaid, and fashion, by successive narrowing, turning, and widening a "toe," save always that when the belt-shipper mechanism, illustrated in Fig. 1, is employed in said operation, the cam Z for the second time meeting and lifting the stud Z^2, moves the shipper-bar upward and thereby causes the notch Z^6 to clear the banking-screw Z^8 into which the prior or first lifting of said shipper had, under the sidewise pull of spring L and the weight of the bar, drawn and left it, so that the shipper-bar is now drawn by said spring L (the screw Z^8 being in the notch Z^5, the inclined connecting-way, and "straight" Z^{12} successively) over toward the leg X, (see Fig. 1,) and the fork Z^{10} controlling the direction of the belt, guides the same on to the idle-wheel W' and brings all, save it, to rest.

In conclusion, although obvious to machine-knitting hosiers, it may be proper to note that in so far as the needles, which are out of action in the narrowing or goring process above referred to, are concerned, each has its shank passed through a loop of the fabric. They, therefore, upon their return to activity interweave the same loops with the gored or narrowed part and produce what initially has the appearance of a pocket, which, as indicated in Fig. 25, the machine being without the shipper and run continuously thereupon, form the successive heel and toe sections of the continuous product. These sections being cut, as upon the line $y\ y$ of Fig. 25, are readily shaped to the stocking-form, Fig 26, &c. On the other hand the fabric made, when the machine has the shipper attached, but before the union of the top edge of the toe to the corresponding extremity of the foot, is, in every particular, a finished piece of hosiery.

Having thus described my invention, what I claim is—

1. In a knitting machine the combination with a cam cylinder and a needle cylinder relatively rotatable, of a shaft as S' operatively connected therewith, means adapted to drive said shaft with a continuous rotary motion, means to drive said shaft with a reciprocatory rotary motion and means adapted to connect the shaft S' alternately with either of the motion transmitting devices and also to hold it out of engagement with both, and a lock arranged to hold the shaft locked in a certain definite position when not held in connection with the motion transmitting devices; whereby the shaft S' and the needle actuating mechanism operated thereby may be given alternately a continuous rotary and a reciprocatory rotary motion and when not so rotating may be held locked from rotation in a certain definite position.

2. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S' operatively connected therewith, a main driving shaft S, means for transmitting continuous circular motion adapted to connect the two shafts, means for transmitting reciprocating circular motion also adapted to connect the two shafts, a member driven from the main shaft and operating in conformity with the pattern of hosiery to be knit, means operated by said member and adapted to put the shaft S' in connection with the shaft S through one or the other of the motion transmitting devices and to hold it disconnected from said shaft S and a lock preventing the rotation of the shaft S' during such time as it is held out of connection with the shaft S whereby the shaft S' together with the needle actuating cylinder, actuated thereby may be given successive continuous and

reciprocatory circular motions corresponding to those of the motion transmitting devices and held from movement when not connected to the driving shaft S substantially for the purpose specified.

3. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, a main driving shaft S, means for transmitting continuous circular motion adapted to connect the two shafts, means for transmitting reciprocatory circular motion and also adapted to connect to two shafts, a cam A of a contour to operate in conformity with the pattern of hosiery to be knit, mechanism operated from the main shaft S for turning said cam, means operated by said cam A and adapted to put the shaft S′ in connection with the shaft S through one or the other of the motion transmitting devices and to hold it disconnected from said shaft S, and a lock preventing the rotation of shaft S′ during such time as it is held out of connection with the shaft S whereby the shaft S′ together with the needle actuating cylinder, actuated thereby, may be given successive continuous and reciprocatory circular motions corresponding to those of the motion transmitting devices and held from movement when not connected to the driving shaft S′ substantially for the purpose specified.

4. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, a main driving shaft S, means for transmitting continuous circular motion adapted to connect the two shafts, means for transmitting reciprocatory circular motion also adapted to connect the two shafts, a clutch member adapted to put the shaft S′ in connection with the shaft S through one or the other of the motion transmitting devices and to hold it disconnected from said shaft S, a lock preventing the rotation of said shaft S′ during such time as it is held out of connection with the shaft S, a shaft S^2 revolved from the driving shaft by suitable means, a cam A fast on the shaft S^2 of contour corresponding to the pattern of hosiery to be knit and operatively connected with the clutch device, all operating together in such a manner that the shaft S′ together with the needle actuating cylinder connected therewith is given alternately continuous and reciprocatory circular motion in accordance with the pattern of hosiery to be knit.

5. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, gear wheels as V′ U′ loosely mounted on said shaft S′, a driving shaft S, a gear V, and reciprocating rack operatively connected to the driving shaft S and adapted to transmit the one continuous and the other reciprocatory circular motion, a clutch member adapted to connect the shafts S and S′ alternately through the two gears and to hold them disconnected, a lock adapted to lock the shaft S′ from motion when it is not connected with the shaft S, a shaft S^2 operatively connected to the driving shaft S by suitable means, a pattern cam A fast on said shaft S^2 and operatively connected to the clutch member, all operating in such a manner that the shaft S′ together with the needle actuating cylinder connected therewith will be given alternate continuous and reciprocatory circular motion in accordance with the pattern of hosiery to be knit.

6. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, gear wheels V′ and U′ journaled loosely on said shaft, a driving shaft S, two gears on said shaft S meshing with gear wheels V′ and U′ and adapted to continuously revolve them during the operation of the machine, the one with continuous and the other with reciprocatory circular motion, a clutch member adapted to alternately connect the shaft S′ to one or the other of said gear wheels and to hold it disconnected from both, a lock operating to hold the shaft S′ from rotation during such times as it is not connected to either of the gear wheels, a shaft S^2 operatively connected to the driving shaft S by suitable means, a pattern cam A fast on said shaft S^2 and operatively connected to the clutch member, all operating in such a manner that the shaft S′ together with the needle actuating cylinder connected therewith will be given alternate continuous and reciprocating circular motion in accordance with the pattern of hosiery to be knit.

7. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, gear wheels V′ U′ loosely journaled on said shaft S′, a driving shaft S, means as a gear wheel V and a reciprocating rack U continuously in gear with the wheels V′ U′ whereby these gear wheels V′ U′ are adapted to be continuously revolved during the operation of the machine, one with a continuous and the other with a reciprocatory circular motion, a clutch member revolving with, but longitudinally movable along said shaft S′ and adapted to connect the said shaft and cause it to revolve with one or the other of said gear wheels and also to disconnect the shaft from both gear wheels, a lock arranged to hold the shaft S′ from rotation when it is not connected with either gear wheel, a shaft S^2 operatively connected to the driving shaft by suitable means, a pattern cam A fast on said shaft S^2 and operatively connected to the clutch member, all operating in such a manner that the shaft S′ together with the needle actuating cylinder connected therewith will be given alternate continuous and reciprocatory circular motion in accordance with the pattern of hosiery to be knit.

8. The combination with a needle and a cam cylinder relatively rotatable, of a shaft S

operatively connected therewith, gear wheels V′ U′ loosely journaled on said shaft and provided with clutch grips, a driving shaft S, means as a spur wheel V and a reciprocating rack U operatively connected with the driving shaft and in gear with the gear wheels V′ U′ and adapted to rotate said wheels concurrently, the one with continuous and the other with reciprocating circular motion, a clutch member arranged to turn with, but movable lengthwise of the shaft S′, said clutch member having clutches to take with the grips on the gear wheels V′ U′ and also a flange as the disk V^2 having a peripheral notch adapted to envelop when mutually registering, a fixed lock as the inwardly projecting tie *j* of the finger J′; and said fixed lock, the whole cooperating so that the sliding clutch member can pass through the intermediate portion of its lengthwise slide between said wheels when said shaft is in a certain definite alignment substantially as and for the purposes hereinbefore described.

9. The combination with a needle and a cam cylinder relatively rotatable, of a shaft S′ operatively connected therewith, gear wheels V′ U′ loosely journaled on said shaft and provided with clutch grips, means for driving gear V′ with a continuous and gear U′ with a reciprocating circular motion, a clutch member arranged to turn with but movable lengthwise of said shaft S′ having clutches adapted to take with the grips on the aforementioned wheels and also a flange as the disk V^2 having a peripheral indentation adapted to envelop when mutually registering, a fixed lock as the inwardly projecting tip *j* of the aligning finger J′, said finger J′ having the lock, a cam shaft S^2 rotated from the driving shaft S by suitable means as a tappet lever *w*′ and a ratchet wheel W^6 fast on the shaft S^2, a cam wheel A fast on and rotating with said shaft S^2, a slider rod for moving the clutch member having springs Q′ Q^2 Q^3 and operated from the cam wheel A all substantially as and for the purposes described.

10. The combination in a knitting machine of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, a main driving shaft S, means operated from the main driving shaft adapted to drive the shaft S′ with a continuous rotary motion; and means, also operated from the main shaft, adapted to drive the shaft S′ with a reciprocatory rotary motion, a clutch member operating to connect the two shafts by means of either one or the other of the motion transmitting devices, a cam shaft S^2, fast and loose ratchet wheels W^6 W^7 secured thereon, pawls P^4 P^5 reciprocated from the driving shaft S and operatively connected with the ratchet wheels W^6 W^7 respectively, means as relatively high teeth on the ratchet wheels for throwing one or the other of the pawls out of operation, a cam wheel A fast on the shaft S^2 and a lever operated by the cam wheel A adapted to operate the clutch member so that it will connect the shafts S and S′ by means of one or the other of the motion transmitting devices.

11. The combination in a knitting machine of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, a driving shaft S, gear wheels V′ U′ loosely journaled on the shaft S′ and provided with clutch grips and rotated from the main driving shaft S the one with continuous and the other with reciprocating circular motion, a clutch member arranged to rotate with but free to slide lengthwise of said shaft S′ and adapted to alternately connect the shaft with one or the other of said gear wheels so that the shaft will rotate with a motion corresponding to that of the gear wheel with which it is connected, means consisting of a slide rod S^4, a block slidingly carried by rod S^4, a spring Q and stops v^6 and v^7 for holding said block in position on the rod S^4, for moving said clutch and holding it in proper position, means for moving the rod and a lock as the finger J′ having tip *j* for holding the gear wheels V′ U′ in a fixed position when not rotating, all operating to connect and disconnect the gear wheels and shaft when the parts are in a definite alignment.

12. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, gear wheels V′ U′ loosely journaled on said shaft and provided with clutch grips and rotated from the driving shaft S, the one with continuous and the other with reciprocating circular motion, a clutch member arranged to rotate with, but free to slide lengthwise of said shaft S′ and adapted to connect the shaft alternately with one or the other of said gear wheels and having a flange as the disk V^2 with peripheral indentation J adapted to envelop when mutually registering, a fixed lock as the projecting tip *j* of an aligning finger J′; the said finger, means, consisting of a slide rod S^4, a block slidingly carried by the rod S^4, a spring Q and stops v^6 and v^7 for holding said block in position on the rod S^4 for moving said clutch, and holding it in proper position, a cam wheel A for moving said slide rod having a contour corresponding to the style of hosiery to be knit, all operating to connect and disconnect the gear wheels and shaft S′ and lock the shaft S′ when not so connected, all movements being made when the parts are in a definite alignment.

13. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S′ operatively connected therewith, gear wheels V′ U′ journaled loosely thereon and provided with clutch grips and rotated from a driving shaft S the one with continuous and the other with reciprocating circular motion, a clutch member rotating with but capable of sliding lengthwise of said shaft S′, adapted to connect the shaft alternately with either gear wheel, a shaft S^2, a fast and an idle ratchet wheel mounted thereon, said wheel being provided with relatively

high teeth as described in conformity with the pattern, the main driving shaft, an oscillating lever w' operatively connected therewith and having a latch spring, pawls P^4 P^5 having detent bearing lugs pivotally connected to said lever and adapted on meeting said relatively high teeth to interchange periods of activity and of rest by alternately latching upon and disengaging each other from said latch spring and the cam wheel A fast on the shaft S^2 and adapted to move the clutch member in accordance with the pattern of hosiery to be knit, all operating substantially as described.

14. In a knitting machine the combination of a needle and a cam cylinder relatively rotatable, a shaft S' operatively connected thereto, gear wheels V' U' loosely mounted on said shaft S', a driving shaft S, a spur wheel V and a reciprocating rack U, operated by the driving shaft S and in gear with the gear wheels V' U' so as to rotate, one with a continuous and the other with a reciprocating circular motion, a clutch member adapted to connect the shaft S' consecutively with one or the other of the gear wheels V' U', a shaft S^2, means for rotating said shaft from the main driving shaft S, a cam wheel A mounted on the shaft S^2, a lever A' a operated thereby and adapted to actuate the clutch member, substantially as described.

15. The combination in a knitting machine with relatively movable cam and needle mechanism as set forth, of a suitably journaled shaft as S, means for rotating it, a lever w', means, as a tappet operatively connected so as to move with said shaft for oscillating lever w' located so that one end thereof comes within range of the means whereby said lever is oscillated, pawls pivotally connected at the other end, each provided with a wedge lug and detent, a spring latch arranged so as to alternately engage said detents, two ratchet wheels, each provided with occasional higher teeth forming pattern surfaces and operating to lift said pawls, and mounted, the one fast, and the other loosely on a shaft S^2, and said shaft, all operating substantially as set forth.

16. The combination in a knitting machine with relatively rotatable cam and needle cylinders, of a driving shaft S, fast and loose pulleys w w' mounted side by side thereon, a pattern surface formed in accordance with the style of hosiery to be knit and mounted on a shaft S^2, said shaft S^2, means for rotating it from the driving shaft, a cam wheel Z rotating with said shaft S^2, a link provided with a rider for reading said cam wheel and operative to raise and unlatch from a banking stud a shipper bar, said shipper bar having a zig-zag W shaped slot as shown, a stud in said slot and a spring tending to pull the shipper bar in a direction to shift an operative belt from the fast to the loose pulley, the whole operating to free said shipper bar and shift the belt from the fast to the loose pulley only at the second full revolution of said shaft S substantially as and for the purpose described.

17. The combination with relatively movable cam and needle cylinders of rotatable pinions U' V'; a shaft S', a rod as S^4 adapted to slide endwise in suitable fixed eyes and provided with one longitudinally adjustable and three fixed abutments, one of said fixed abutments being located upon an extension of said rod outside of both of said fixed eyes and the remaining abutments located between them substantially as described; springs as Q' Q^3 helically coiled along said rod and operative to thrust the same endwise in the direction of said exterior fixed abutment, as p^{20}; a sliding piece as U^2 adapted to engage with a change of motion clutch and adapted to be guided by said sliding rod; a spring helically coiled along said sliding rod and adapted to thrust said sliding piece away from the central and toward the remaining internal fixed abutment v^7; a lever as A' a, provided with a forked disk bearing end adapted to thrust against said adjustable abutment in a direction contrary to that in which the two first mentioned springs act upon said rod; a cam wheel as A adapted to rotate in rubbing contact with the other end of said lever, and a clutch member provided with an intermitted part as J, a fixed finger as J' adapted to register with the intermitted part of said clutch member, the whole operative in conjunction to slide said clutch member endwise, align, lock, and release the same radially, substantially as and for the purposes hereinbefore described.

18. The combination in a knitting machine of a stationary cylinder as H having needle actuating cam paths located wholly within one half side of said cylinder, a series of knitting needles engaging therewith, a rotating needle cylinder as I, a needle rest as B^2 movably secured in the side of the cam cylinder opposite to that containing the cam paths and adapted to underlie the heels of all such active needles as are not at any given time within said semicylindrical area, levers pivoted outside of the said cylinders, a cam for actuating said levers, connections uniting said levers with said needle rest, and mechanism for automatically actuating said cam, the whole operative to occasionally reciprocate said needle rest and cause a group of needles to become non-active, substantially as and for the purposes hereinbefore described.

19. The combination in a knitting machine of a cam cylinder as H having a needle actuating cam path located wholly within one half of said cylinder and adapted for the production of a tubular and gored web, a series of needles adapted to engage with said cam path, a needle cylinder as I arranged concentrically with the cam cylinder, the cylinders operating when one is rotated relatively to the other to reciprocate the needles in stitch waves, a vibrating needle depressor flap as e^4 located over the non-active area of

the cam cylinder, a pivoted lever actuated by a cam and connected at one end to the flap e^4, a cam E adapted to actuate said lever to depress the flap, means for actuating said cam and means for retracting said flap after the cam has ceased to act, the whole operating to depress needles after "turning" heels and toes of hosiery substantially as and for the purpose specified.

20. In a knitting machine the combination with a fixed cam cylinder and a rotatable needle cylinder designed on rotation of said needle cylinder to operate a series of knitting needles in stitch waves, of a driving shaft as S, a shaft S^2 located externally to said cylinders, means for driving said shaft S^2 from the driving shaft S, a series of cams on the shaft S^2 adapted to be rotated thereby, a series of pivoted levers adapted to read and be actuated by said cams and needle lifters and depressors in the cylinders connected with the pivoted levers and actuated thereby, all operating to raise and depress needles in the cylinders in accordance with the designed pattern.

21. In combination with the rotative needle cylinder I, an annular driving chuck seat I', and a spring latch adapted to lock said cylinder to, and unlock it from said seat, substantially as and for the purpose hereinbefore described.

22. The combination of the needle cylinder I, provided with radially projecting latches, a rotative driving chuck I' adapted to seat said cylinder and engage with said latches, and means for retracting said latches, the whole operating to alternately lock and release said cylinder and said driving chuck at will, substantially as and for the purpose hereinbefore described.

23. In a circular knitting machine the combination of the cam cylinder, a flap F' pivoted to said cylinder, and adapted, when swung upward, to present its upper part within and above the top of said cylinder, a pendulous needle depressor finger F^2 pivoted to the upper part of said flap, and means for latching said finger with its needle engaging part in range of the non-active needles, a cam F, and lever $f f^5$ operative to swing said flap on its pivot, and bring said needle depressor finger into active position within said cam cylinder preparatory to widening, substantially as and for the purpose described.

24. In a circular knitting machine the combination of the cam cylinder, a flap F' pivoted to said cylinder, and adapted, when swung upward, to present its upper part within and above the top of said cylinder, pendulous depressor fingers F^2 F^3 pivoted to said flap, and means for latching said fingers alternately with their needle engaging parts in range of the non-active needles, a V shaped central depressor cam N' located between said depressors and adapted to pass non-active needles received from said depressor fingers into the knitting cam paths, a cam as F and a pivoted lever adapted to be actuated by said cam and connected to said flap and operative to swing said flap on its pivot and bring said needle depressor fingers into active position within said cam cylinder, the whole operating to return needles from either end of a non-active series to activity substantially for the purpose described.

25. In a knitting machine the combination of the stationary cylinder H, provided below a non-active level with cams adapted to form a normal stitch wave cam path in either direction, a pivoted flap F', adapted when swung upward to present its upper part within and above the top of said cylinder; a cam as F, a lever actuated thereby and operative to vibrate said flap, automatic mechanism for intermittently operating said cam and lever in conformity with the pattern of hosiery to be knit, pendulous depressor fingers F^2 F^3 pivoted to the upper part of said flap, and means for latching said fingers alternately with their needle engaging parts in the path of non-active needles, the whole operative automatically to return needles alternately from either end of a non-active series to activity substantially for the purpose described.

26. The combination in a knitting machine of a rotatable needle cylinder and a fixed cam cylinder provided with a normal stitch wave cam path, of a shaft S' operatively connected with the needle cylinder, gear wheels V' U' journaled loosely on said shaft, a driving shaft, means operated thereby as a spur wheel V and a reciprocating rack U adapted to transmit respectively continuous and reciprocating circular motion to the shaft S', a clutch member operative to connect the shafts S' and S successively through each of the motion transmitting devices, a cam wheel A connecting with the clutch member and operating in accordance with the pattern of hosiery to be knit whereby the shaft S' and the needle cylinder operated thereby are given motions corresponding to those of the motion transmitting devices, a shaft S^2 operated from the driving shaft in accordance with the pattern, a cam wheel C fixed to said shaft S^2, a fulcrumed lever having one end c^5 adapted to read the periphery of the cam wheel C and having whiskers as c^2 extending through slots in the cam cylinder, and pivoted needle lifter tumblers n^4 n^5 each provided on its free swing extremity with notches adapted to engage with the knitting needle actuating parts, the whole operating automatically to move said tumblers' notched extremities in or out of the cam path substantially for the purpose specified.

27. In a circular knitting machine the combination of the cylinder driving shaft S', the change of motion wheels V' U' journaled loosely on said shaft, and a clutch member located medially between said wheels and arranged to turn with said driving shaft but free to move longitudinally thereon, said clutch member being provided on either end

respectively with outwardly projecting studs P^2 P^3 arranged to engage with holes u^{10} v^{10} in the sides of wheels V′ U′ and intermediate thereto, with a circumferential disk as V^2 having a gap J, said studs each substantially equal in length to the width of said gap bearing disk V^2, and a fixed finger J′ provided with an inwardly projecting tip *j*, the converse of said gap, the whole being arranged substantially as and for the purpose specified.

28. In a circular knitting machine the combination of the movable needle cylinder I, mechanism operative to drive the same with continuous and with reciprocating circular motion, the fixed cam cylinder H provided with a system of cams, said cam system adapted to produce the normal stitch wave when traversed in either direction and located wholly below a non-active level, a series of knitting needles mutually engaging with said cylinders and operative for continuous or reciprocating knitting, right and left by-path cams N^2 N^3 outlying said system and adapted to pass needles delivered to them into said non-active level, right and left needle lifter tumblers pivoted beneath the cam path of said cam system within range respectively of aforesaid by-path cams and adapted to engage on the actuating part (heels) of said needles, outlying guard cams N^5 N^6 operative to replace accidentally displaced needles prior to entering the cam system proper, adjustable seats for said needle lifter tumblers, a pivoted lever connected to the needle lifter tumblers and a cam for actuating said lever and controlling the tumblers and pattern surfaces, actuated automatically from the driving mechanism, controlling the relative positions of said cam and lever in conformity with the progress of the knitting function, the whole operating to suffer said tumblers to lie passively below the cam system of said cam cylinder during continuous circular knitting of the leg or foot, but operative between changes from continuous to reciprocating motion in said needle cylinder to lift said tumblers into active positions for narrowing and finally on the completion of said operation, to return them to their normal position, substantially as and for the purposes hereinbefore described.

29. In a circular knitting machine, the fixed cam cylinder H provided with ancillary devices for turning and lifting and depressing groups of needles simultaneously and means for lifting and depressing single needles, the movable needle cylinder I, an endless pattern surface, mechanism for actuating the same with an intermittent motion from the driving mechanism, said driving mechanism consisting of a drive shaft S adapted to drive the shaft S′ with a continuous and reciprocating circular motion with intervals of rest between said motions by means of gears V′ U′, said gears, spur wheel V and reciprocating rack U substantially as specified, said shaft or its equivalent, the secondary rotatable cam system secured upon a common shaft as an axis, said shaft S^2 suitably journaled and located externally to said fixed cam cylinder means for operating said shaft conformably to the movements of said pattern surface, a system of levers pivoted so as to read the cams of said secondary cam system and automatically actuate by the vibrations produced thereby, aforesaid ancillary devices for widening and narrowing in accordance with the reading of said secondary cam system when called into activity by said pattern surface substantially as and for the purposes hereinbefore described.

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Witnesses:
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